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Samuel Henshaw

PHYSICO-THEOLOGY:

OR, A

DEMONSTRATION

OF THE

Being and Attributes of GOD,

FROM HIS

WORKS of CREATION.

Being the SUBSTANCE of

SIXTEEN SERMONS

Preached in St. Mary le Bow Church, London,

At the Honourable Mr. BOYLE's LECTURES,
in the Years 1711, and 1712.

With Large NOTES and many Curious Obſervations.

By W. DERHAM,
Canon of Windſor, Rector of Upminſter, in Eſſex, and F.R.S.

Mala & impia conſuetudo eſt contra Deos diſputare, ſive animo id fit, ſive ſimulate. CIC. de Nat. Deor. lib. ii. fine.

The THIRTEENTH EDITION.

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MDCCLXVIII.

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TO THE

Moſt Reverend Father in GOD,

THOMAS,

Lord Archbiſhop of CANTERBURY,

Primate of All *ENGLAND*, *&c.*

The Surviving TRUSTEE of the Honourable

Mr. *BOYLE*'s LECTURES.

May it pleaſe Your GRACE,

I MAY juſtly put theſe LECTURES under your GRACE's Patronage, their Publication being wholly owing to You: for having the Honour to be a Member of the ROYAL SOCIETY, as well as a *Divine*, I was minded to try what I could do towards the Improvement of *Philoſophical* Matters to *Theological* Uſes; and accordingly laid a Scheme of what I have here Publiſhed a Part of; and when I had little elſe to do, I drew up what I had to ſay, making it rather the diverting Exerciſes of my *leiſure Hours*, than more ſerious *Theological Studies*. This Work (although I made a conſiderable Progreſs in it at firſt, whilſt a Novelty, yet) having no Thoughts of Publiſhing, I laid aſide, until your GRACE, being informed of my Deſign by ſome of my Learned Friends, both of the Clergy and Laity, was pleaſed to call me to the unexpected Honour of Preaching Mr. *Boyle*'s LECTURES: An Honour I was little aware of in my Country Privacy, and not much acquainted with Perſons in High Stations, and not at all particularly with your GRACE. So that therefore as it pleaſed Your GRACE, not only to confer an unſought profitable Honour upon me (a Stranger) but alſo to continue it for two Years, out of Your good Opinion of my Performance, in ſome Meaſure, anſwering Mr. *Boyle*'s End; ſo I can do no leſs than make this Publick, grateful Acknowledgment of Your GRACE's great and unexpected Favour.

But it is not myſelf alone, but the whole LECTURE alſo is beholden to Your GRACE's kind and pious Endeavours. It was You that encouraged this Noble Charity, and aſſiſted in the Settlement of it, in the Honourable

Founder's Life-time; and Since his Death, it was You that procured a more certain Salary for the LECTURERS, paid more conſtantly and duly than it was before*.

Theſe Benefits, as I myſelf have been a Sharer of, ſo I ſhould be very ungrateful, ſhould I not duly acknowledge, and repay with my repeated Thanks and good Wiſhes. And that the Infinite Rewarder of Well-doing, may give Your GRACE a plentiful Reward of theſe, and Your many other, both Publick and Private, Benefactions, is the hearty Wiſh of

---

* It may not only gratify the Reader's Curioſity, but alſo be of Uſe for preventing Encroachments in Time to come, to give the following Account of Mr. *Boyle*'s Lectures.

Mr. *Boyle*, by a Codicil, dated *July* the 28th, 1691, and annexed to his Will, charged his Meſſuage, or Dwelling-Houſe, in St. *Michael*'s *Crooked-Lane*, *London*, with the Payment of the clear Yearly Rents and Profits thereof to ſome Learned Divine in *London*, or within the Bills of Mortality, to be Elected for a Term not exceeding Three Years, by his Grace the preſent Lord Archbiſhop of *Canterbury* (then Dr. *Teniſon*) Sir *Henry Aſhurſt*, Sir *John Rotherham*, and *John Evelyn*, Eſq. The Buſineſs he appointed thoſe Lectures for, was, among others, *To be ready to ſatisfy real Scruples, and to anſwer ſuch new Objections and Difficulties as might be ſtarted, to which good Anſwers had not been made.* And alſo, *To Preach Eight Sermons in the Year*; viz. *the firſt* Monday, *of* January, February, March, April, *and* May; *and of* September, October, *and* November. The Subject of theſe Sermons was to be, *The Proof of the Chriſtian Religion againſt Notorious Infidels*; viz. *Atheiſts, Pagans, Jews, and Mahometans*; *not deſcending lower to any Controverſies that are among Chriſtians themſelves.* But by reaſon the Lecturers were ſeldom continued above a Year, and that the Houſe ſometimes ſtood empty, and Tenants brake, or failed in due Payment of their Rent, therefore the Salary ſometimes remained long unpaid, or could not be gotten without ſome Difficulty: To remedy which Inconvenience, his preſent Grace of *Canterbury* procured a Yearly Stipend of 50*l.* to be paid Quarterly for Ever, charged upon a Farm in the Pariſh of *Brill*, in the County of *Bucks*: Which Stipend is accordingly very duly paid, when demanded, without Fee or Reward.

Your GRACE's

Moſt Humble and Thankful

Son and Servant,

W. DERHAM.

TO THE

READER.

AS *the Noble* Founder *of the* LECTURES *I have had the Honour of preaching, was a great Improver of* Natural Knowledge, *ſo, in all Probability, he did it out of a pious End, as well as in Purſuit of his* Genius. *For it was his ſettled Opinion, that nothing tended more to cultivate true Religion and Piety in a Man's Mind, than a thorough Skill in Philoſophy. And ſuch Effect it manifeſtly had in him, as is evident from divers of his publiſhed Pieces; from his conſtant Deportment in* never mentioning the Name of GOD without a Pauſe, and viſible Stop in his Diſcourſe; *and from the noble Foundation of his Lectures for the Honour of* GOD, *and the generous Stipend he allowed for the ſame.*

Vide Biſhop BURNET'*s Funeral Sermon*, p. 24.

And foraſmuch as his Lectures were appointed by him for the Proof of the Chriſtian Religion againſt Atheiſts and other notorious Infidels, *I thought, when I had the Honour to be made his Lecturer, that I could not better come up to his Intent, than to attempt a Demonſtration of the* Being *and* Attributes of God, *in what I may call Mr.* Boyle's *own, that is, a* Phyſico-Theological *Way. And, beſides that, as it was for this very Service that I was called to this Honour, I was the more induced to follow this Method, by reaſon none of my Learned and ingenious Predeceſſors in theſe Lectures have done it on purpoſe, but only caſually, in a tranſient piece-meal Manner; they having made it their Buſineſs to prove the Great Points of Chriſtianity in another Way, which they have accordingly admirably done. But conſidering what our* Honourable Founder's *Opinion was of* Natural Knowledge, *and that his Intent was, that thoſe Matters, by paſſing through divers Hands, and by being treated of in different Methods, ſhould take in moſt of what could be ſaid upon the Subject; I hope my Performance may be acceptable, although one of the meaneſt.*

Vide Mr. Boyle's *Will.*

As for others, who have before me done ſomething of this kind, as Merſenne *on* Geneſis; *Dr.* Cockburne *in his* Eſſays; *Mr.* Ray *in his* Wiſdom of God, *&c. and I may add the firſt of Mr.* Boyle's Lecturers, *the moſt learned Dr.* Bently, *in his* Boyle's Lectures, *the eloquent Archbiſhop of* Cambray (*and, I hear, the inge-*

nious Monſieur Perault *hath ſomething of this Kind, but never ſaw it) I ſay, as to theſe learned and ingenious Authors, as the Creation is an ample Subject, ſo I induſtriouſly endeavoured to avoid doing over again what they before had done, aud for that Reaſon did not, for many Years; read their Books, until I had finiſhed my own. But when I came to compare what each of us had done, I found myſelf in many Things to have been anticipated by ſome or other of them, eſpecially by my Friend, the late Great Mr.* Ray. *And therefore in ſome Places I ſhorten'd my Diſcourſe, and referred to them; and in a few others, where the Thread of my Diſcourſe would have been interrupted, I have made uſe of their Authority, as the beſt Judges; as of Mr.* Ray's *for Inſtance, with relation to the Mountains, and their Plants, and other Projects. If then the Reader ſhould meet with any thing mentioned before by others, and not accordingly acknowledged by me, I hope he will candidly think me no Plagiary, becauſe I can aſſure him I have all along (where I was aware of it) cited my Authors with their due Praiſe. And it is ſcarce poſſible, when Men write on the ſame, or a Subject near a-kin, and the Obſervations are obvious, but that they muſt often hit upon the ſame Thing: And frequently this may happen from Perſons making Obſervations about one and the ſame Thing, without knowing what each other hath done; which indeed, when the firſt Edition of my Book was nearly printed off, I found to be my own Caſe, having (for want of Dr.* Hook's

Micrography *being at hand, it being a very ſcarce Book, and many Years ſince I read it) giving Deſcriptions of two or three Things, which I thought had not been tolerably well obſerved before, but are deſcribed well by that curious Gentleman.*

One is a Feather, *the Mechaniſm of which we in the main agree in, except in his Repreſentation in* Fig. 1. Scheme 22. *which is ſomewhat different from what I have repreſented in* Fig. 18. &c. *But I can ſtand by the Truth, though not the Elegance of my Figures. But as to the other Differences, they are accidental, occaſioned by our taking the Parts in a different View, or in a different Part of a Vane; and, to ſay the Truth, (not flattering myſelf, or detracting from the admirable Obſervations of that Great Man) I have hit upon a few Things that eſcaped him, being enabled to do ſo, not only by the Help of ſuch Microſcopes as he made uſe of; but alſo by thoſe made by Mr.* Wilſon, *which exceed all I ever ſaw, whether of* Engliſh, Dutch, *or* Italian Make; *ſeveral of which Sorts I have ſeen and examined.*

The other Thing we have both of us figured and deſcribed, is, The Sting of a Bee or Waſp; *in which we differ more than in the laſt. But by a careful Re-examination, I find, that although Dr.* Hook's *Obſervations are more critical than any were before, yet they are not ſo true as mine. For as to the* Scabbard *(as he calls it) I could never diſcover any Beards thereon; and I dare be confident there are none,* *but what are on the two Spears. And as to the Point of the* Scabbard, *he hath repreſented it as tubular, or bluntiſh at the Top; but it really terminates in a ſharp Point, and the two Spears and the Poiſon come out of a Slit, or longiſh Hole, a little below the Top or Point. And as to the Spears, he makes them to be but one, and that the Point thereof lies always out of the Scabbard. But by a ſtrict Examination, they will be found to be two, as I have ſaid, and that they always lie within the* Scabbard, *except in Stinging; as I have repreſented them, in* Fig. 21. *from the tranſparent Sting of a Waſp. And as to the Spear being made of the Joints, and parted into two, as his* Fig. 2. Scheme 16. *repreſents, I could never, upon a Review, diſcover it to be ſo, but imagine, that by ſeeing the Beards lying upon, or behind the Spears, he might take them for Joints, and by ſeeing the Point of one Spear lie before the other, he might think the Spear was parted in two. But leſt the Reader ſhould think himſelf impoſed upon by Dr.* Hook, *and my* Self, *it is neceſſary to be obſerved, that the* Beards *(or* Tenterhooks, *as Dr.* Hook *calls them) lie only on one Side of each Spear, not all round them; and are therefore not to be ſeen, unleſs they are laid in a due Poſture in the Microſcope;* viz. *ſide-ways, not under, or atop the Spear.*

The laſt Thing (which ſcarce deſerves mention) is the Mechaniſm of the Hair, *which Dr.* Hook *found to be ſolid, like a long Piece of Horn, not hollow, as* Malpighi *found it in ſome Animals. And*

And I have found both thoſe Great Men to be in ſome Meaſure in the Right, the Hair of ſome Animals, or in ſome Parts of the Body, being very little, if at all, tubular; and in others, particularly Mice, Rats, *and* Cats, *to be as I have repreſented in my* Fig. 14, *&c.*

And now, if my Inadvertency in other Things hath no worſe Effect than it hath had in theſe, namely, to correct, or clear others Obſervations, I hope the Reader will excuſe it, if he meets with any more of the like Kind. But not being conſcious of any ſuch thing (although probably there may be many ſuch) I am more ſollicitous to beg the Reader's Candor and Favour, with relation both to the Text *and* Notes: *In the former of which, I fear he will think I have as much under-done, as in the latter over-done the Matter. But for my Excuſe, I deſire it may be conſidered, That the textual Part being Sermons, to be delivered in the Pulpit, it was neceſſary to inſiſt but briefly upon many of the Works of* GOD, *and to leave out many Things that might have been admitted in a more free Diſcourſe. So that I wiſh it may not be thought I have ſaid too much, rather than to little, for ſuch an Occaſion and Place. And indeed, I had no ſmall Trouble in expunging ſome Things, altering many, and ſoftening the moſt, and, in a word, giving, in ſome Meaſure, the Whole a different Dreſs than what I had at firſt drawn it up in, and what it now appears in.*

And as for the Notes, *which may be thought too large, I confeſs I might have ſhortened them;*

and had Thoughts of doing it, by caſting ſome of them into the Text, as an ingenious learned Friend adviſed. But when I began to do this, I found it was in a Manner to new-make all; and that I ſhould be neceſſitated to tranſcribe the greateſt Part of the Book, which (having no Aſſiſtant) would have been too tedious for me, being pretty well fatigued with it before. I then thought it beſt to pare off from ſome, and to leave out others, and accordingly did ſo in many Places, and would have done it in more, particularly in many of the Citations *out of the* Ancients, *both Poets and others; as alſo in many of the* Anatomical Obſervations, *and many of my own and others Obſervations: But then I conſidered, as to the Firſt, that thoſe Citations do (many of them at leaſt) ſhew the Senſe of Mankind about* GOD's *Works, and that the moſt of them may be acceptable to young Gentlemen at the Univerſities, for whoſe Service theſe Lectures are greatly intended. And as to the Anatomical Notes, and ſome others of the like Nature, moſt of them ſerve, either to the Confirmation, or the Illuſtration, or Explication of the Text, if not to the learned, yet to the unſkilful, leſs learned Reader; for whoſe Sake, if I had added more, I believe he would forgive me. And laſtly, as to the Obſervations of myſelf, and ſome others, where it happens that they are long, it is commonly where a Neceſſity lay upon me of fully expreſſing the Author's Senſe, or my own, or where the Thing was new, and never before publiſhed; in which Caſe, it was neceſſary to be more Expreſs* *and Particular, than in Matters better known, or where the Author may be referred unto.*

In the former Editions I promiſed another Part I had relating to the Heavens, *if I was thereunto encouraged. And two large Impreſſions of this Book having been ſold off, ſo as to admit of a Third before the Year was gone about; and hearing that it is tranſlated into two, if not three Languages: but eſpecially having been importuned by divers learned Perſons, both known and unknown, I have thought myſelf ſufficiently engaged to perform that Promiſe; aud have accordingly publiſhed that Part.*

So that I have now carried my Survey *through moſt Parts of the viſible Creation, except the* Waters, *which are for the moſt Part omitted; and the* Vegetables, *which, for want of Time, I was forced to treat of in a perfunctory Manner. And to the Underſtanding of the former of theſe, having received divers Solicitations from Perſons unknown, as well as known, I think myſelf bound in Civility to own their Favour, and to return them my hearty Thanks for the kind Opinion they have ſhewn of my other Performances, that they have encouraged me to undertake this other Taſk. And accordingly I have begun it, and (as far as my Affairs will permit) have made ſome Progreſs in it: But Age and Avocations growing upon me, I begin to fear I ſhall ſcarce be able to finiſh it as I would, and therefore muſt recommend that ample aud noble Subject to others, who have more Leiſure and would do it better than I.*

As to Additions, *I have been much ſollicited thereunto by divers curious and learned Perſons, who would have had me to inſert ſome of their Obſervations, and many more of my own; but in a Work of this Nature, this would have been endleſs: And although the Book would thereby be rendered much better, and more complete, yet I could by no means excuſe ſo great an Injuſtice to the Purchaſers of the former Editions. And therefore (except in the ſecond Edition, where it was not eaſy to be avoided) few Additions have been made, beſides what were Typographical or of ſmall Conſideration. Only in the third Edition I amended the firſt Paragraph of* Note 1. Chap. 5. Book I. *concerning* Gravity; *and in the Fourth,* Page 16, *and* 18, *I inſerted two Paſſages out of* Seneca, *that were inadvertently left out, and corrected many Things, that upon a careful Review, ſeemed to want Amendment.*

And laſtly, as to the following Analyſis, *it was added at the Requeſt of ſome of my learned and ingenious Friends; and although it might have been contracted, they would not ſuffer it to be ſo.*

AN ANALYSIS OF THE FOLLOWING BOOK.

THE Works of the Creation relating to our Terraqueous Globe, are ſuch as are viſible in the

- Outworks or Appendages of the Globe, *viz.* theſe Three:
  - 1. The Atmoſphere,
    - Compoſed of Air and Vapours, *Page* 4.
    - Uſeful to
      - Reſpiration and Animal Life, 5.
      - Vegetation of Plants, 9.
      - Conveyance of
        - The winged Tribes.
        - Sound, 11.
      - The Functions of Nature.
      - Reflecting and Refracting Light, 12.
    - Containing the
      - Winds, which are of great Uſe and Neceſſity
        - To the Salubrity and Pleaſure of the Air, 14.
        - In various Engines, 18.
        - In Navigation.
      - Clouds and Rain: Of great Uſe to the
        - Refreſhment of the Earth and the Things therein, 20.
        - Origin of Fountains, according to ſome, 23.
  - 2. Light. Its
    - Fountain, 26.
    - Wonderful Neceſſity and Uſe.
    - Improvement by Glaſſes, 28.
    - Velocity.
    - Expanſion, 29.
  - 3. Gravity.

- Its great Benefit, 33.
- Cauſe of *Levity*, which is of great Uſe in the World, 35

Terraqueous Globe itſelf. Of which I take a View in

- General, of
  - Its ſpherical Figure, which is the moſt commodious in regard of
    - Light, 40.
    - Heat.
    - Lodgment of the Waters.
    - The Winds. 41.
  - Its Bulk, 43.
  - Its Motion, *ibid.*
    - Annual.
    - Diurnal.
  - Its Place and Diſtance from the Sun, and other Heavenly Bodies, 46.
  - Its Diſtribution, ſo as to cauſe all the Parts of the Globe to
    - Balance each other, 48.
    - Be helpful to one another.
  - The great Variety and Quantity of all Things ſerving for Food, Phyſick, Building, and every Uſe and Occaſion of all Ages, Places, and Creatures, 53.
  - An Objection anſwered, 55.
- Particular, of the Earth; of its
  - Conſtituent Parts, *viz.* Its
    - Soils and Moulds, neceſſary to the
      - Growth of various Vegetables, 61.
      - Various Occaſions of Man and other Animals, 62.
    - Various Strata or Beds, affording Materials for
      - Tools.
      - Firing.
      - Building.
      - Dying, and thouſands of other Things, 64.
      - Conveyance of the ſweet Fountain-Waters, 65.
    - Subterraneous Caverns and Vulcanos; of great Uſe to the Countries where they are, 67.
  - Mountains and Valleys, which are not rude Ruins, but Works of Deſign, inaſmuch as this Structure of the Earth is
    - The moſt Beautiful and Pleaſant.
    - The moſt Salubrious: to ſome Conſtitutions, the Hills; To ſome, the Valleys, 71.
    - Beſt to ſkreen us, and other Things, 72.
    - Beneficial to the
      - Production of various Vegetables.
      - Harbour and Maintenance of various Animals, 73.
      - Generation of Minerals and Metals, 75.
    - Abſolutely neceſſary to the Conveyance of the Rivers; and in all Probability to the Origin of Fountains, *ib.*

Con-

- Concluſion againſt blaming GOD, 81.
- Its Inhabitants; which are either *Senſitive* or *Inſenſitive*.
  Concerning the
- Senſitive, ſome Things are
  - Common to all the Tribes, particularly theſe Ten:
    - I. The Five Senſes and their Organs; the, 85.
      - Eye, an admirable Piece of Mechaniſm in regard of its
        - Form, for the moſt Part Spherical, which is beſt for
          - The Reception of Objects.
          - Motion of the Eye, 90.
        - Situation in the moſt commodious Part of the Body of every Creature.
        - Motion, in ſome Animals.
          - Every Way.
          - Fixed; and the excellent Proviſion in that Caſe, 91.
        - Size; which is in
          - All Creatures, according to their Occaſions.
          - Such as live Abroad in the Light, larger.
          - Such as live under Ground, leſs.
        - Number, in ſome Animals:
          - Two, 94.
          - More: Together with the wiſe Proviſion to prevent double Viſion.
        - Parts; ſome of which are viewed
          - Tranſiently, the Arteries, Veins, and ſome of the Muſcles and Tunicks.
          - More ſtrictly, ſome of the
            - Muſcles, and the excellent Proviſion made for their peculiar Uſes, Equilibration, &c. 96.
            - Tunicks: Among which the various Apertures, Forms, and Poſitions of the Pupil are particularly noted, 99.
            - Humours, eſpecially the prodigious Finery and Compoſition of the Cryſtalline, according to Mr. *Lewenhoeck*.
            - Nerves, 105.
              - Optick.
              - Motory.
        - Guard and Security, provided for by
          - The Reparation of the Aqueous Humour.
          - Covering of the Eye-lids.
          - Strong and curious Bones.
          - Hard and firm Tunicks.
          - Withdrawing them into their Heads, 109.
      - Of erect Viſion, 111.

Hearing. Its
- Organ, the Ear, 113.
  - Double, enabling us to hear every Way, and a good Proviſion for the Loſs or Hurt of one.
  - Situated in the very beſt Place for Information, Security, and near the Eye and Brain.
  - The Fabrick of the
    - Outward Ear, which is in
      - All Creatures formed, guarded, placed, and every way accoutered according to their various Places and Occaſions 115.
      - Man ſuitable to his erect Poſture; and all its Parts, the *Helix*, *Tragus*, *Concha*, &c. admirably ſuited to the Reception and Melioration of Sounds, and the Security of the Part.
    - Inward Ear: In which I take a View of the 121,
      - Auditory Paſſage, curiouſly tunnelled, tortuous, and ſmooth; and being always open, is lined with the nauſeous Ear-wax for a Guard.
      - Tuba Euſtachiana 122.
      - Bone, particularly hard and context for Guard, and to aſſiſt the Sound.
      - Tympanum, and its Membrane, Muſcles, and four little Bones to correſpond to all Kinds of Sound.
      - Labyrinth, Semicircular Canals, Cochlea; all made with the utmoſt Art 127.
      - Auditory Nerves, one of which is ramified to the Eye, Tongue, Muſcles of the Ear, and to the Heart; whence a great Sympathy between thoſe Parts 128.
- Object, Sound. Under which I conſider,
  - The Improvements thereof by the Wit of Man 129.
  - Its great Neceſſity, and excellent Uſes 132.
  - Its Pleaſure, and the Power of Muſick 134.

Smelling. In which Senſe theſe Things are remarkable, the
- Noſtrils, always open, cartilaginous, and endowed with Muſcles 137.
- Laminæ, ſerving for
  - A Guard againſt noxious Things 138.
  - The ſpreading of the Olfactory Nerves.
- Prodigious Uſe of it in all, eſpecially ſome of the Irrationals 139.

Taſte. The Things moſt remarkable in which Senſe are, the
- Nerves ſpread about the Tongue and Mouth, with their Guard.
- The Papillæ, neatly made 140.

  - Situation thereof to be a Centinel to the Stomach and Food.
  - Conſent thereof with the other Senſes, by ſome Branches of the fifth Pair 141.
- Feeling 142.
  - Whoſe Organ is the Nerves 143.
  - Which is diſperſed through every Part of the Body, and the admirable Benefit thereof.

II. Reſpiration the grand Act of Animal Life 145.

- Miniſtring to the Circulation of the Blood, and Diaſtole of the Heart.
- The Parts concerned therein are,
  - The Larynx, with its great Variety of Muſcles, &c. for Reſpiration, and forming the Voice 148.
  - Trachea and Epiglottis, exquiſitely contrived and made.
  - Bronchi and Lungs, with their curious Arteries, Veins, and Nerves 150.
  - Ribs, Diaphragm, and the ſeveral Muſcles concerned.
- Its Defects in the
  - Fœtus in the Womb 153.
  - Amphibious Creatures 157.
  - Some Animals in Winter.

III. The Motion of Animals: Concerning which I conſider

- Tranſiently the
  - Muſcles, and their Structure, their Size, Faſtening to the Joints, Motions, &c. 158.
  - Bones, and their curious make.
  - Joints, with their Form, Bandage, and Lubricity 161.
  - Nerves, and their Origine, Ramifications, and Inoſculations.
- More particularly the Loco-motive Act itſelf, which is
  - Swift or ſlow, with Wings, Legs many or few, or none at all, according to the various Occaſions and Ways of Animals Lives. As particularly in
    - Reptiles, whoſe Food and Habitation is near at hand.
    - Man and Quadrupeds, whoſe Occaſions require a larger Range, and therefore a ſwifter Motion 164.
    - Birds, and Inſects, whoſe Food, Habitation, and Safety require yet a larger Range, and have accordingly a yet ſwifter Motion and direct Conveyance.
  - Geometrically and neatly performed by the niceſt Rules.
  - Well provided for by the
    - Due Equipoiſe of the Body 165.
    - Motive Parts being accurately placed with regard to the Center of the Body's Gravity, and to undergo their due Proportion of Weight and Exerciſe.

IV. The *Place* allotted to the ſeveral Tribes of Animals to Live and Act in. Concerning which I obſerve, that
- Their Organs are adapted to their Place 167.
- All Places habitable are duly ſtocked.
- Various Animals have their various Places; and the Wiſdom thereof 168.

V. The Balance of Animals Numbers, ſo that the World is not
- Overſtocked by their Increaſe.
- Depopulated by their Death.

Which is effected in
- The ſeveral Tribes of Animals by a due Proportion in the
  - Length of their Life 169.
  - Number of their Young, in
    - Uſeful Creatures being many.
    - Pernicious few.
- Man very remarkably, by the
  - Different Length of his Life,
    - Soon after the Creation 171.
    - When the World was more, but not fully Peopled *ibid.*
    - When it was ſufficiently ſtocked, down to the preſent Time.
  - Due Proportions of Marriages, Births, and Burials 174.
  - Balance of Males and Females 175.

VI. The Food of Animals. In which the Divine Management and Providence appears, in the 179.
- Maintaining ſuch large Numbers of all Kinds of Animals on the Land, in the Seas, and divers Places too unlikely to afford ſufficient Food.
- Adjuſtment of the Quantity of Food to the Number of Devourers, ſo that
  - There is not too much, ſo as to rot, and annoy the World 181.
  - The moſt Uſeful is the moſt Plentiful, and eaſieſt Propagated *ibid.*
- Delight which the various Tribes of Animals have to the Varieties of Food, ſo that what is grateful to one, is nauſeous to another: Which is a wiſe Means to cauſe
  - All Creatures to be ſufficiently ſupplied.
  - All ſorts of Food to be conſumed.
  - The World to be kept ſweet and clean by thoſe Means 183.
- Peculiar Food, that particular Places afford to the Creatures reſiding therein 184.
- Curious Apparatus in all Animals for Gathering, and Digeſtion of their Food, *viz.* the

- Mouth, nicely ſhaped for Food, &c. In
  - Some, little and narrow 189.
  - Some, with a large deep Inciſure.
  - Inſects very notable to catch, hold, and devour Prey; to carry Burdens, to bore and build their Habitations 190.
  - Birds as notable, Horned in all. In ſome
    - Hooked for Rapine, Climbing, &c. 192.
    - Sharp and ſtrong to pierce Trees, &c.
    - Long and ſlender to grope.
    - Long and broad to quaffer.
    - Thick and ſharp-edged to huſk Grain.
    - Compreſſed to raiſe Limpets, &c.
- Teeth, which are peculiarly hard, firmly inſerted in the Jaws, variouſly ſhaped in the ſame, and different Animals, deficient in young Creatures, &c. 194.
- Salival Glands, commodiouſly placed for Maſtication and Deglutition 196.
- Muſcles and Tendons, ſerving to Maſtication, ſtrong and well lodged.
- Gullet, ſized according to the Food; with curious Fibres, &c. *ibid.*
- Stomach; 197.
  - Which hath a curious Mechaniſm of Fibres, Tunicks, Glands, Nerves, Arteries, and Veins.
  - Whoſe Faculty of Digeſtion by ſuch ſeeming weak Menſtruums is admirable.
  - Whoſe Size and Strength is conformable to the Nature of the Food, or Occaſions of Animals.
  - Which is in
    - Tame Animals but one.
    - Ruminants, Birds, &c. more.
- Guts, whoſe Tunicks, Glands, Fibres, Valves, and Periſtaltick Motion, deſerve Admiration 201.
- Lacteals, together with the Impregnations from the Pancreas, Gall, Glands, and Lymphæducts.

Sagacity of all Animals in finding out, and providing Food. In
- Man leſs remarkable for the Sake of his Underſtanding 202
- Inferior Creatures. In ſuch as are
  - Come to mature Age, and are able to help themſelves, by their
    - Accurate Smell 203.
    - Natural Craft.
    - Hunting and groping out of Sight.
    - Seeing and Smelling at great Diſtances 205.
    - Climbing; the ſtrong Tendons and Muſcles acting therein.
    - Seeing in the dark.
  - Helpleſs. As 207.

- Young Creatures.
  - Man, born the moſt helpleſs of any, the Parents Reaſon, Hands, and Affection ſufficing.
  - Irrationals: For whoſe Young the Creator hath made a ſufficient Proviſion, partly by the
    - Parent Animals own
      - Στοργὴ and Diligence in Nurſing and Defending them 207.
      - Sagacity and Care in repoſiting their Eggs and Young, where Food and all Neceſſaries are to be found 209.
    - Ability of the Young themſelves to ſhift for, and help themſelves, with the little Helps of their Dams 210.
- Creatures deſtitute of Food at ſome Seaſons, or likely to want it, who
  - Are able to live long without Food 211.
  - Lay up Food before-hand.

VII. The Cloathing of Animals, which is 214.
- Suited to the Place and Occaſions of all. In
  - Man it is left to his own Reaſon and Art, joined with ſufficient Materials: Which is beſt for him,
    - Becauſe he may ſuit his Cloathing to his Quality and Buſineſs 218.
    - For Perſpiration and Health ſake.
    - To exerciſe his Art and Induſtry.
    - To excite his Diligence in keeping himſelf ſweet and clean.
    - In being the Parent of divers Callings 219.
  - Irrationals: Who are either
  - Ready furniſhed with proper Cloathing,
    - On the dry Land with Hair, Fleeces, Furs, Shells, hard Skins, &c. 220.
    - In the Air with Feathers, light, ſtrong, and warm.
    - In the Waters with Scales, hard for Guard; ſmooth for Paſſage; or with ſtrong Shells to guard ſuch as move more ſlowly 223.
  - Provide for themſelves by their Textrine, or Architectonick Art. Of which under the next Branch.
- Well garniſhed, being all Workman-like, compleat, in its Kind beautiful, being 224.
  - Adorned with gay, various and elegant Colours.
  - If ſordid, yet with exact Symmetry, and full of curious Mechaniſm.

VIII. The Houſes and Habitations of

- **Man**, who is abundantly furniſhed with
  - Contrivance and Art to build and garniſh his Habit tions 226.
  - Materials of all ſorts to effect his Works.
- **Irrationals**, whoſe marvellous Inſtinct is manifeſted by
  - Convenience of their Neſts and Habitations for the
    - Hatching and Education of their Young 228.
    - Guard and Defence of themſelves and their Young
  - **Fabrick** of their Neſts, ſcarce imitable by Man, a ſhewn by their Contrivance and Make, being exact ſuitable to their Occaſions, and made by
    - Putting only a few ugly Sticks, Moſs, Dirt, &c. tog ther 231.
    - Building Combs according to the beſt Rules of Math maticks.
    - Weaving Webs, and making Caſes. For which Se vice the Parts of their Bodies, and Materials afford by them, are very conſiderable.
- **IX.** Animals Self-Preſervation. For which there is ways a Guard in Proportion to the Dangers and Occ ſions of their State. Which is obſervable in
  - Man, whoſe Reaſon and Art ſupplies the Defect Natural Armature.
  - Irrational Creatures: who
    - As they are on one hand ſufficiently guarded by th
      - Shells, Horns, Claws, Strings, &c. 239.
      - Changing their Colours.
      - Wings, Feet, and Swiftneſs.
      - Diving in, and tinging the Waters.
      - Ejecting Juices out of their Body.
      - Accurate Smell, Sight, and Hearing.
      - Natural Craft 243.
      - Uncouth Noiſe, ugly Geſticulations, and hor Aſpect.
      - Horrible Stink and Excrements.
    - So on the other hand can by their Strength, Sagaci or natural Artifices entrap and captivate what neceſſary for their Food and other Occaſions.
- **X.** Animals Generation.
  - Equivocal, is denied 244.
  - Univocal: Which of
    - Man, is εὐπρέπειας ἕνεκα paſſed wholly by
    - Irrational Creatures, which is remarkable for thei
      - Sagacity in chuſing the fitteſt Place for their Egg and Young: Where it is obſervable what a

C

- Compleat Order they obſerve.
- Neat Apparatus their Bodies are provided with for this Purpoſe 248.
- Natural Venom they inject with their Eggs into Vegetables to pervert Nature, and produce Balls, and Caſes 250.

- Making Uſe of the fitteſt Seaſons, either
  - All Seaſons 251.
  - When Proviſions are moſt plentiful and eaſieſt had.
- Due Number of Young 252.
- Diligence and Concern for their Young, in point of
  - Incubation 253.
  - Safety and Defence 254.
- Faculty of Nurſing their Young, by
  - Suckling them. In which it is obſervable
    - How ſuitable this Food is.
    - How willingly parted with by all, even the moſt ſavage.
    - What a compleat Apparatus in all Creatures of Dugs, *etc.*
  - Putting Food in their Mouths, with their proper Parts for catching and conveying Food 255.
  - Neither way, but by laying in Proviſions beforehand 256

Having in the Fourth Book thus diſpatched the Decad of Things in common to the *Senſitive Creatures*, I take a View of their particular Tribes, *viz.* of

- *Man*; whom I conſider with Relation to his
  - Soul. Concerning which, having curſorily mentioned divers things, I inſiſt upon two, as ſhewing an eſpecial divine Management; the
    - Various Genii, or Inclinations of Men, which is a wiſe Proviſion for the Diſpatch of all the World's Affairs, and that they may be performed with Pleaſure 263
    - Inventive Faculty, in which it is remarkable that
      - Its Compaſs is ſo large, extending to all Things of Uſe, and occaſioning ſo many ſeveral Callings.
      - Things of greateſt Neceſſity and Uſe were ſoon and eaſily found out; but Things leſs Uſeful, later; and dangerous Things, not yet. Here of divers particular Inventions, with an Exhortation to exerciſe and improve our Gifts.
  - Body. In which the Things particularly remarked upon are the
    - Erect Poſture 282.
      - The moſt convenient for a Rational Being.
      - Manifeſtly intended, as appears from the Structure of ſome particular Parts mentioned 285.
      - Nice Structure of the Parts miniſtring thereto.
      - Equilibration of all the Parts 286.

- Figure and Shape of Man's Body moſt agreeable to his Place and Buſineſs 287
- Stature and Size, which is much the beſt for Man's State 288
- Structure of the Parts, which are
  - Without Botches and Blunders.
  - Of due Strength.
  - Of the beſt Form.
  - Moſt accurately accommodated to their proper Offices.
- Lodgment of the Parts, as the
  - Five Senſes 297.
  - Hand.
  - Legs and Feet.
  - Heart.
  - Viſcera.
  - Several Bones and Muſcles, *etc.* 298
  - Covering of all with the Skin.
- Proviſion in Man's Body to
  - Prevent Evils by the
    - Situation of the Eyes, Ears, Tongue, and Hand 300
    - Guard afforded all, eſpecially the principal Parts.
    - Duplication of ſome Parts.
  - Cure of Evils by means of
    - Proper Emunctories 301
    - Diſeaſes themſelves making Diſcharges of Things more dangerous 303
    - Pain giving Warning, and exciting our Endeavours.
- Conſent of the Parts, effected by the Nerves, a Sample whereof is given in the Fifth Pair, branched to the Eye, Ear, *etc.*

Political, ſociable State. For the Preſervation and Security of which the Creator hath taken Care by Variety of Mens
- Faces 308
- Voices.
- Hand-Writing.

Quadrupeds. Of which I take no Notice, but wherein they differ from Man, *viz.*

- Prone Poſture, which is conſiderable for
  - The Parts miniſtring to it, eſpecially the Legs and Feet, ſized and made in ſome for
    - Strength and ſlow Motion 315.
    - Agility and Swiftneſs.
    - Walking and Running.
    - Walking and Swimming.
    - Walking and Flying.
    - Walking and Digging.

- Traverſing the Plains.
- Traverſing Ice, Mountains, &c.
- Its Uſefulneſs to
  - Gather Food 317.
  - Catch Prey.
  - Climb, Leap, and Swim.
  - Guard themſelves.
  - Carry Burdens, Till the Ground, and other Uſes of Men.
- Parts differing from thoſe of Men.
  - Head, wherein I conſider
    - Its Shape, commonly agreeable to the Animal's Motion 319.
    - The Brain, which is
      - Leſſer than in Man 319.
      - Placed lower than the Cerebellum.
    - The Nictitating Membrane 321.
    - Carotid Arteries, and Rete Mirabile.
    - Nates.
  - Neck.
    - Anſwering the Length of the Legs 322.
    - Strengthened by the Whitleather.
  - Stomach 324.
    - Correſponding to the ſeveral Species.
    - Suited to their proper Food, whether Fleſh, Grain, etc.
  - Heart: Its
    - Ventricles in ſome
      - One only 325.
      - Two.
      - Three, as ſome think.
    - Situation nearer the midſt of the Body, than in Man.
    - Want of the Faſtening of the Pericardium to the Midriff 327.
  - Nervous Kinds. A Sample of which is given in the different Correſpondence between the Head and Heart of Man and Beaſt, by the means of the Nerves 329.
- *Birds*. Concerning which I take a View of their
  - Body and Motion; where I conſider
    - The Parts concerned in their Motion 333.
      - The Shape of the Body, made exactly for ſwimming in, and paſſing through the Air.
      - Feathers, which are
        - Moſt exactly made for Lightneſs and Strength.
        - All well placed in every Part, for the Covering and Motion of the Body.
        - Preened and dreſſed 334.
      - Wings, which are
        - Made of the very beſt Materials, *viz.* of *Bones*,

        - light and ſtrong; *Joints* exactly opening, ſhutting, and moving, as the Occaſions of Flight require; and the *Pectoral Muſcles*, of the greateſt Strength of any in the whole Body.
      - Placed in the niceſt Point of the Body of every Species, according to the Occaſions of Flight, Swimming, or Diving.
    - Tail, which is well made, and placed to keep the Body ſteady, and aſſiſt in its Aſcents and Deſcents 337.
    - Legs and Feet, which are made light for Flight, and incomparably accoutered for their proper Occaſions of
      - Swimming 338.
      - Walking.
      - Catching Prey.
      - Rooſting.
      - Hanging.
      - Wading and Searching the Waters.
      - Lifting them upon their Wings.
  - Motion itſelf
    - Performed by the niceſt Laws of Mechanicks.
    - Anſwering every Purpoſe and Occaſion.
  - Other Parts of the Body, *viz.* the
    - Head remarkable for the commodious
      - Shape of itſelf 341.
      - Forms of the Bill.
      - Site of the Eye and Ear.
      - Poſition of the Brain.
      - Structure of the
        - Larynx.
        - Tongue.
        - Inner Ear.
      - Proviſion by Nerves in the Bill for taſting and diſtinguiſhing Food 344.
    - Stomachs, one to
      - Macerate and prepare 345.
      - Grind and digeſt.
    - Lungs incomparably made for
      - Reſpiration 346.
      - Making the Body buoyant.
    - Neck, which is made
      - In due Proportion to the Legs.
      - To ſearch in the Waters, and
      - To counterpoiſe the Body in Flight.
- State. Of which I take Notice of three Things, *viz.* their

- Migration remarkable for
  - The Knowledge Birds have of
    - Their Times of Paſſage 348.
    - The Places proper for them.
  - Their Accommodation for long Flights by long or elſe ſtrong Wings.
- Incubation, which is conſiderable for
  - The Egg, and its Parts 351.
  - Act itſelf; that theſe Creatures ſhould betake themſelves to it, know this to be the Way to produce their Young, and with Delight and Patience ſit ſuch a due Number of Days.
  - The Neglect of it in any, as the Oſtrich, and the wonderful Proviſion for the Young in that Caſe 354.
- Nidification. Of which before.

Inſects. Which although a deſpiſed Tribe, doth in ſome Reſpects more ſet forth the infinite Power and Wiſdom of the Creator, than the larger Animals.

The Things in this Tribe remarked upon are their

- Body 359.
  - Shaped, not ſo much for long Flights, as for their Food, and Condition of Life.
  - Built not with Bones, but with what ſerves both for Bones and Covering too.
  - Eyes, reticulated to ſee all Ways at once 360.
  - Antennæ, and their Uſe 361.
  - Legs and Feet made for
    - Creeping 363.
    - Swimming and Walking.
    - Hanging on ſmooth Surfaces.
    - Leaping.
    - Digging.
    - Spinning and Weaving Webs and Caſes.
  - Wings, which are
    - Nicely diſtended with Bones 365.
    - Some incomparably adorned with Feathers and elegant Colours.
    - Some jointed and folded up in their Elytra, and diſtended again at Pleaſure.
    - In Number either
      - Two, with Poiſes.
      - Four, without Poiſes.
  - Surprizing Minuteneſs of ſome of thoſe Animals themſelves, eſpecially of their Parts, which are as numerous and various as in other Animal Bodies 367.
- State: which ſets forth a particular Concurrence of the Divine Providence, in the wiſe and careful Proviſion that is made for their

- Security againſt Winter, by their
  - Subſiſting in a different, *viz.* their Nympha or Aurelia-State 369.
  - Living in Torpitude, without any Waſte of Body or Spirits 370.
  - Laying up Proviſion before-hand.
- Preſervation of their Species by their
  - Chuſing proper Places, to lay up their Eggs and Sperm, ſo that the
    - Eggs may have due Incubation 373.
    - Young ſufficient Food.
  - Care and Curioſity in repoſiting their Eggs in neat Order, and with the proper Part uppermoſt 382.
  - Incomparable Art of Nidification, by being endowed with
    - Parts proper for, and agreeable to the ſeveral Ways Of Nidification, and the Materials they uſe in it.
    - Architectonick Sagacity to build and weave their Cells, or to make even Nature herſelf their handmaid 384.
- *Reptiles.* Which agreeing with other Animals in ſomething or other before treated of, I conſider only their
  - Motion, which is very remarkable, whether we conſider the
    - Manner of it, as
      - Vermicular 394.
      - Sinuous.
      - Snail-like.
      - Caterpillar-like.
      - Multipedous.
    - Parts miniſtring to it.
  - Poiſon, which ſerves to
    - Scourge Man's Wickedneſs 398.
    - Their eaſy Capture and Maſtery of their Prey.
    - Their Digeſtion.
- Watery Inhabitants conſiderable for their
  - Great Variety 401.
  - Prodigious Multitudes.
  - Vaſt Bulk of ſome, and ſurprizing Minuteneſs of others 402
  - Incomparable Contrivance and Structure of their Bodies.
  - Supplies of Food.
  - Reſpiration.
  - Adjuſtment of their Organs of Viſion to their Element.
  - Poiſe and Motion of the Body every Way 403.

Inſenſitive Inhabitants. Among which having mentioned Foſſils and others, I inſiſt only upon *Vegetables*, and that in a curſory Manner upon their

- Great Variety for the ſeveral Uſes of the World 404.
- Anatomy.
- Leaves 407.
- Flowers, and their admirable Gaiety.
- Seed, remarkable for its

Generation.
Make.
Containing in it a compleat Plant 408.
Preſervation and Safety in the Gems, Fruit, Earth, *&c.*
Sowing, which is provided for by Down, Wings, Springy Caſes carried about by Birds, ſown by the Huſbandman, *etc.* 412.
Growing and Standing: Some by
Their own Strength 417.
The Help of others, by claſping about, or hanging upon them.
Remarkable Uſe, eſpecially of ſome which ſeem to be provided for the Good of
All Places 420.
Some particular Places, to
Heal ſome Local Diſtempers.
Supply ſome Local Wants.

Practical Inferences upon the Whole are theſe Six. *viz.* That GOD's Works
1. Are Great and Excellent 425.
2. Ought to be enquired into, with a Commendation of ſuch as do ſo 427.
3. Are manifeſt to all, and therefore Atheiſm unreaſonable 428.
4. Ought to excite Fear and Obedience 431.
5. Ought to excite Thankfulneſs 432.
6. Should move us to pay God his due Homages and Worſhip, particularly that of the Lord's Day: which is an Appointment

The moſt Antient 438.
Wiſely contrived for Diſpatch of Buſineſs, and to prevent Carnality.
Whoſe proper Buſineſs is, to ceaſe from Worldly, and to follow Spiritual Employments; the Chief of which is the Publick Worſhip of GOD.

A SURVEY OF THE TERRAQUEOUS GLOBE.

INTRODUCTION.

IN *Pſal.* cxi. 2. the Pſalmiſt aſſerts; That *the* (a) *Works of the Lord are great; ſought out of all them that have Pleaſure therein.* This is true of all *God's Works*, particularly of his *Works of Creation*: Which, when *ſought out*, or, as the *Hebrew* Word (b) ſignifieth, when *heedfully* and *deeply pried into, ſolicitouſly obſerved*

(a) It is not unlikely that the Pſalmiſt might mean, at leaſt have an Eye to, *the Works of the Creation* in this Text, the Word מעשה being the ſame that in *Pſal.* xix. 1. is tranſlated *God's Handy-work*, which is manifeſtly applied to the Works of *Creation*, and properly ſignifieth *Factum*, *Opus*, *Opificium*, from עשה *Fecit*, *Paravit*, *Aptavit*. And, ſaith *Kircher*, *Significat talem affectionem, quâ aliquid exiſtit vel realiter, vel ornate, vel ut non ſit in priſtino ſtatu quo fuit.* Concord. p. 2. col. 931.

(b) דרש *Quæſivit, perquiſivit, ſciſcitatus eſt.* Buxtor. in verb. *Et ſimul importat curam, & ſolicitudinem.* Conrad. Kirch. ib. p. 1. col. 1174.

and enquired out, eſpecially when clearly diſcovered to us; in this Caſe, I ſay, we find thoſe Works of God abundantly to deſerve the Pſalmiſt's Character of being *Great* and Noble; inaſmuch, as they are made with the moſt exquiſite Art, (*c*) contrived with the utmoſt Sagacity, and ordered with plain wiſe Deſign, and miniſtring to admirable Ends. For which reaſon St. *Paul* might well affirm of thoſe Ποιήματα of God (*d*), That the *inviſible Things of God, even his eternal Power and Godhead, are underſtood by them.* And indeed they are the moſt eaſy, and intelligible Demonſtrations of the *Being* and *Attributes of* God; (*e*) eſpecially to ſuch as are unacquainted with the

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(c) Quod ſi omnes mundi partes ita conſtitutæ ſunt, ut neque ad uſum meliores potuerint eſſe, neque ad ſpeciem pulchripres; videamus utrùm ea fortuita ſint, an eo ſtatu, quo cohærere nullo modo potuerint, niſi ſenſu moderante divinâque providentiâ. Si ergo meliora ſunt ea quæ Naturâ, quàm illa, quæ Arte perfecta ſunt, nec Ars efficit quid ſine ratione, ne Natura quidem rationis expers eſt habenda. Qui igitur convenit, ſignum, aut tabulam pictam cum adſpexeris, ſcire adhibitam eſſe artem; cumque procul curſum navigii videris, non dubitare, quin id ratione atque arte moveatur: aut cùm Solarium, &c. Mundum autem, qui & has ipſas artes, & earum artifices, & cuncta complectatur, conſilii & rationis eſſe expertem putare? Quod ſi in Scythiam, aut in Britanniam, Sphæram aliquis tulerit hanc, quam nuper familiaris noſter effecit Poſidonius, cujus ſingulæ converſiones idem efficiunt in Sole, &c.—— quod efficitur in cœlo ſingulis diebus & noctibus; quis in illâ barbarie dubitet, quin ea Sphæra ſit perfecta Ratione? Hi autem dubitant de Mundo, ex quo & oriuntur, & fiunt omnia, caſune ipſe ſit effectus, — an Ratione, an Mente divinâ? Et Archimedem arbitrantur plus valuiſſe in imitandis Sphæræ converſionibus, quàm Naturam in efficiendis, præſertim cùm multis partibus ſint illa perfecta, quam hæc ſimulata, ſolertius, &c. Cic. de Nat. lib. ii. cap. 34, 35.

(d) And a little before he ſaith of *Nature* itſelf, *Omne ergo regit Naturam ipſe* [Deus] *&c.*

(e) Mundus codex eſt Dei, in quo jugiter legere debemus. Bernard. Serm.

Arbitror nullam gentem, neque Hominum ſocietatem, apud quos ulla Deorum eſt religio, quidquam habere ſacris Eleuſiniis aut Samothraciis ſimile: Ea tamen obſcurè docent quæ profitentur: Naturæ verò opera in omnibus animantibus ſunt perſpicua. Galen. de Uſ. Part. lib. xvii. cap. 1.

Subtilties of Reaſoning and Argumentation; as the greateſt Part of Mankind are.

It may not therefore be unſuitable to the Nature and Deſign of Lectures *(f)* founded by one of the greateſt Virtuoſo's of the laſt Age, and inſtituted too on purpoſe for the Proof of the Chriſtian Religion againſt Atheiſts, and other Infidels, to improve this Occaſion in the Demonſtration of the *Being* and *Attributes* of an infinitely wiſe and powerful Creator, from a Curſory Survey of the Works of *Creation*, or (as often called) of *Nature*.

Which Works belong either to our *Terraqueous Globe*, or the *Heavens*.

I ſhall begin with our own *Globe*, being neareſt, and falling moſt under our Senſes. Which being a Subject very various and copious, for the more methodical and orderly proceeding upon it, I ſhall diſtribute the Works therein:

I. Into ſuch as are not properly Parts, but *Appendages* or *Out-works* of the Globe.

II. The *Globe* itſelf.

(f) *Philoſophia eſt Catechiſmus ad Fidem.* Cyril. 1. contra Jul.

BOOK I.

Of the Out-Works of the Terraqueous Globe; the Atmoſphere, Light, and Gravity.

CHAP. I.

Of the Atmoſphere in General.

THE Atmoſphere, or Maſs of Air, Vapours, and Clouds, which ſurrounds our Globe, will appear to be a Matter of Deſign, and the infinitely wiſe Creator's Work, if we conſider its *Nature* and *Make (a)*, and its *Uſe* to the World *(b)*.

1. Its Nature and Make, a Maſs of Air, of ſubtile penetrating Matter, fit to pervade other Bodies, to penetrate into the inmoſt Receſſes of Nature, to excite, animate, and ſpiritualize; and, in ſhort, to be the very Soul of this lower World. A Thing conſequently,

2. Of greateſt Uſe to the World, uſeful to the Life, the Health, the Comfort, the Pleaſure, and Buſineſs of the whole Globe. It is the Air the

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(a) *Mundi pars eſt Aer, & quidem neceſſaria: Hic eſt enim qui cœlum terramque connectit, &c.* Senec. Nat. Qu. lib. ii. c. 4.

(b) *Ipſe Aer nobiſcum videt, nobiſcum audit, nobiſcum ſonat; nihil enim eorum ſine eo fieri poteſt, &c.* Cic. de Nat. Deor. lib. ii. cap. 33.

whole Animal World breatheth, and liveth by; not only the Animals inhabiting the Earth (*c*) and Air,

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(*c*) As the Air is of abſolute Neceſſity to Animal Life, ſo it is neceſſary that it ſhould be of a due Temperament or Conſiſtence; not foul, by reaſon that ſuffocateth; nor too rare and thin, becauſe that ſufficeth not: with examples of each of which I ſhall a little entertain the Reader. In one of Mr. *Hawkſbee's* Compreſſing Engines, I cloſely ſhut up a *Sparrow*, without forcing any Air in; and in leſs than an Hour the Bird began to pant, and be concerned; and in leſs than an Hour and half to be ſick, vomit, and more out of Breath; and in two Hours time was nearly expiring.

Another I put in and compreſſed the Air, but the Engine leaking, I frequently renewed the Compreſſure; by which Means, (although the Bird panted a little after the firſt Hour) yet after ſuch frequent Compreſſures, and Immiſſion of freſh Air, it was very little concerned, and taken out ſeemingly unhurt after three Hours.

After this I made two other Experiments in compreſſed Air, with the Weight of two Atmoſpheres injected, the Engine holding tight and well; the one with the *Great Titmouſe*, the other with a *Sparrow*. For near an Hour they ſeemed but little concerned; but after that grew fainter, and in two Hours time ſick, and in three Hours time died. Another thing I took Notice of, was, that when the Birds were ſick, and very reſtleſs, I fancied they were ſomewhat relieved for a ſhort Space, with the Motion of the Air, cauſed by their fluttering and ſhaking their Wings, (a Thing worth trying in the *Diving-Bell.*) I ſhall leave the ingenious Reader to judge what the Cauſe was of both the Birds living longer in compreſſed, than uncompreſſed Air; whether a leſs Quantity of Air was not ſooner fouled and rendered unfit for Reſpiration than a greater.

From theſe Experiments two Things are manifeſted; one is, that Air, in ſome meaſure compreſſed, or rather heavy, is neceſſary to Animal Life: Of which by and bye. The other, that freſh Air is alſo neceſſary; for pent-up Air, when overcharged with the Vapours emitted out of the Animal's Body, becomes unfit for Reſpiration. For which Reaſon, in the *Diving-Bell*, after ſome time of ſtay under Water, they are forced to come up and take in freſh Air, or by ſome ſuch Means recruit it. But the famous *Cornelius Drebell* contrived not only a Veſſel to be rowed under Water, but alſo a Liquor to be carried in that Veſſel, that would ſupply the Want of Freſh Air. The Veſſel was made for King *James* I. It carried twelve Rowers, beſides the Paſſengers. It was tried in the River of *Thames*; and one of the Perſons that was in that ſubmarine Navigation was then alive, and told it one, who related the Matter to our famous Founder, the Honourable and moſt Ingenious Mr. *Boyle*. As to the Liquor, Mr. *Boyle* ſaith, he diſcovered by a Doctor of Phyſick, who married *Drebell*'s Daughter, that it was uſed from time to time, when the Air, in the ſubmarine Boat, was clogged by the Breath of the Company, and thereby made unfit for Reſpiration; at which time, by unſtopping a Veſſel full of this Liquor, he could ſpeedily reſtore to the troubled Air ſuch a Proportion of vital Parts, as would make it again for a good while fit for Reſpiration. The Secret of this Liquor *Debrell* would never diſcloſe to above one Perſon, who himſelf aſſured Mr. *Boyle* what it was. *Vide* Boyle's *Exp. Phyſ. Mech. of the Spring of the Air, Exp.* 41. in the *Digreſſion*. This Story I have related from Mr. *Boyle*. But at the ſame time much queſtion, whether the Virtues of the Liquor were ſo effectual as reported.

And as too groſs, ſo too rare an Air is unfit for Reſpiration. Not to mention the forced Rarefactions made by the Air-Pump, in the following Note; it is found, that even the extraordinary natural Rarefactions, upon the Tops of very high Hills, much affect Reſpiration. An Eccleſiaſtical Perſon, who had viſited the high Mountains of *Armenia*, (on which ſome fancy the Ark reſted) told Mr. *Boyle*, that whilſt he was on the upper Part of them, he was forced to fetch his Breath oftener than he was wont. And taking Notice of it when he came down, the People told him, that it was what happened to them when they were ſo high above the Plane, and that it was a common Obſervation among them. The like Obſervation the ſame Eccleſiaſtick made upon the Top of a Mountain in the *Cevennes*, So a learned Traveller, and curious Perſon, on one of the higheſt Ridges of the *Pyranees*, called *Pic de Midi*, found the Air not ſo fit for Reſpiration, as the common Air, but he and his Company were fain to breathe ſhorter and oftener than in the lower Air. *Vide Phil. Tranſact.* N° 63. or *Lowthorp's Abridgment*, vol. ii. p. 226.

Such another Relation the learned *Joſeph Acoſta* gives of himſelf, and his Company, that, when they paſſed the high Mountains of *Peru*, which they call *Periacaca*, (to which he ſaith, *the Alps themſelves ſeemed to them but as ordinary Houſes, in regard of high Towers,) he, and his Companions, were ſurprized with ſuch extreme Pangs of Straining and Vomiting, (not without caſting up of Blood too), and with ſo violent a Diſtemper, that he concludes he ſhould undoubtedly have died; but that this laſted not above three or four Hours, before they came into a more convenient and natural Temperature of the Air.* All which, he concludes, proceeded from the too great Subtilty and Delicacy of the Air, which is not proportionable to human Reſpiration, which requires a more groſs and temperate Air. *Vide Boyle, ubi ſupra.*

Thus it appears, that an Air too Subtile, Rare, and Light, is unfit for Reſpiration: But the Cauſe is not the Subtilty, or too great Delicacy, as Mr. *Boyle* thinks, but the too great

Air (*d*), but thoſe of the waters (*e*) too. Without it moſt Animals live ſcarce half a minute (*f*); and others,

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Lightneſs thereof, which renders it unable to be a Counterbalance, or an Antagoniſt to the Heart, and all the Muſcles miniſtring to *Reſpiration*, and the *Diaſtole* of the Heart. Of which ſee Book IV. Chap. vii. Note *a*.

And as our Inability to live in too rare and light an Air, may diſcourage thoſe vain Attempts of Flying, and Whimſies of paſſing to the Moon, &c. ſo our being able to bear an heavier State of the Air is an excellent Proviſion for Mens Occaſions in Mines, and other great Depths of the Earth; and thoſe other greater Preſſures made upon the Air, in the *Diving-bell*, when we deſcend into great Depths of the Waters.

(*d*) That the Inhabitants of the Air (Birds and Inſects,) need the Air as well as Man, and other Animals, is manifeſt from their ſpeedy dying in too feculent, or too much rarified Air; of which ſee the preceding and following Note *f*. But yet Birds and Inſects (ſome Birds at leaſt) can live in a rarer Air than Man. Thus Eagles, Kites, Herons, and divers other Birds, that delight in high Flights, are not affected with the Rarity of the Medium, as thoſe Perſons were in the preceding Note. So Inſects bear the Air-Pump long, as in the following Note *f*.

(*e*) Creatures inhabiting the Waters need the Air, as well as other Animals, yea, and freſh Air too. The *Hydrocanthari* of all Sorts, the *Nymphæ* of *Gnats*, and many other Water-Inſects, have a ſingular Faculty and an admirable Apparatus, to raiſe their Back-parts to the Top of the Waters, and take in freſh Air. It is pretty to ſee, for Inſtance, the *Hydrocanthari* come and thruſt their Tails out of the Water, and take in a Bubble of Air, at the Tip of their *Vaginæ* and Tails, and then nimbly carry it down with them into the Waters; and, when that is ſpent, or fouled, to aſcend again and recruit it.

So Fiſhes alſo are well known to uſe Reſpiration, by paſſing the Water through their Mouths and Gills. But *Carps* will live out of the Water, only in the Air, as is manifeſt by the Experiment of their Way of Fatting them in *Holland*, and which hath been practiſed here in *England*, *viz.* they hang them up in a Cellar, or ſome cool Place, in wet Moſs in a ſmall Net, with their Heads out, and feed them with white Bread ſoaked in Milk, for many Days. This was told me by a Perſon very curious, and of great Honour and Eminence, whoſe Word (if I had leave to name him) no body would queſtion: And it being an Inſtance of the Reſpiration of Fiſhes very ſingular, and ſomewhat out of the way, I have, for the Reader's Diverſion, taken notice of it.

(*f*) By Experiments I made myſelf in the Air-Pump, in others, that are the moſt accuſtomed to the Want of it, live not without it many Days.

And not only Animals themſelves but even Trees and Plants, and the whole vegetable Race, owe their Vegetation and Life to this uſeful Element; as will appear when I come to ſpeak of them, and

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September and *October*, 1704, I obſerved that Animals whoſe Hearts have two *Ventricles*, and no *Foramen ovale*, as Birds, Dogs, Cats, Rats, Mice, *&c.* die in leſs than half a Minute, counting from the very firſt Exſuction; eſpecially in a ſmall Receiver.

A *Mole* (which I ſuſpected might have borne more than other Quadrupeds) died in one Minute (without Recovery) in a large Receiver; and doubtleſs would hardly have ſurvived half a Minute in a ſmall Receiver. A *Bat* (although wounded) ſuſtained the Pump two Minutes, and revived upon the Re-admiſſion of the Air. After that, he remained four Minutes and a half, and revived. Laſtly, after he had been five Minutes, he continued gaſping for a Time, and after twenty Minutes I re-admitted the Air, but the *Bat* never revived.

As for *Inſects*: *Waſps*, *Bees*, *Hornets*, *Graſhoppers*, and *Lady-Cows*, ſeemed dead in Appearance in two Minutes, but revived in the open Air in two or three Hours time, notwithſtanding they had been *in vacuo* twenty-four Hours.

The *Ear-wig*, the great *Staphylinus*, the great black lowſy *Beetle*, and ſome other Inſects, would ſeem unconcerned at the *Vacuum* a good while, and lie as dead; but revive in the Air, although ſome had lain ſixteen Hours in the exhauſted Receiver.

Snails bear the Air-Pump prodigiouſly, eſpecially thoſe in Shells; two of which lay above twenty-four Hours, and ſeemed not much affected. The ſame Snails I left in twenty-eight Hours more after a ſecond Exhauſtion, and found one of them quite dead, but the other revived.

Frogs and *Toads* bear the Pump long, eſpecially the former. A large Toad, found in the Houſe, died irrecoverably in leſs than ſix Hours. Another Toad and Frog I put in together, and the Toad was ſeemingly dead in two Hours, but the Frog juſt alive. After they had remained there eleven Hours, and ſeemingly dead, the Frog recovered in the open Air, only weak, but the Toad was quite dead. The ſame Frog being put in again for twenty-ſeven Hours, then quite died.

The Animalcules in *Pepper-water* remained *in vacuo* twenty-four Hours. And after they had been expoſed a Day or two to the open Air, I found ſome of them dead, ſome alive.

is manifeſt from their Glory and Verdure in a free Air, and there becoming Pale and Sickly, and Languiſhing and Dying, when by any means excluded from it *(g)*.

Thus uſeful, thus neceſſary, is the Air to the Life of the animated Creatures; and no leſs is it to the Motion and Conveyance of many of them. All the winged Tribes owe their Flight and Buoyancy *(h)* to it, as ſhall be ſhewn in proper Place: And even the watry Inhabitants themſelves cannot aſcend and deſcend into their Element, well without it *(i)*.

But

(g) That the Air is the principal Cauſe of the Vegetation of Plants, *Borelli* proves, in his excellent Book *De Mot. Animal.* Vol. ii. Prop. 181. And, in the next Propoſition, he aſſureth, *In Plantis quoque peragi Aeris reſpirationem quandam imperfectam, à quâ earum vita pendet, & conſervatur.* But of this more, when I come to ſurvey Vegetables.

Some Lettuce Seed being ſown upon ſome Earth in the open Air, and ſome of the ſame Seed, at the ſame Time, upon other Earth in a Glaſs Receiver of the Pneumatic Engine, afterwards exhauſted of Air: The Seed expoſed to the Air, was grown up an Inch and half high within Eight Days; but that in the exhauſted Receiver not at all. And Air being again admitted into the ſame emptied Receiver, to ſee whether any of the Seed would then come up, it was found, that in the Space of one Week it was grown up to the Height of two or three Inches. Vide Phil. Tranſact. N° 23. Lowth. Abridg. vol. ii. p. 206.

(h) In volucribus pulmones perforati aerem inſpiratum in totam ventris cavitatem admittunt. Hujus ratio, ut propter corporis truncum Aere repletum & quaſi extenſum, ipſa magis volatilia evadant, faciliuſque ab aere externo, propter intimi penum, ſuſtententur. Equidem piſces, quò leviùs in aquis natent, in Abdomine veſicas Aere inflatas geſtant: Pariter & volucres, propter corporis truncum Aere impletum & quaſi inflatum, nudo Aeri incumbentes, minus gravantur, proindeque leviùs & expeditiùs volant. Willis de Anim. Brut. p. i. cap. 3.

(i) Fiſhes, by Reaſon of the Bladder of Air within them, can ſuſtain, or keep themſelves in any Depth of Water: For the Air in that Bladder being more or leſs compreſſed, according to the Depth the Fiſh ſwims at, takes up more or leſs Space; and conſequently, the Body of the Fiſh, part of whoſe Bulk this Bladder is, is greater or leſs according to the ſeveral Depths, and yet retains the ſame

Weight,

But it would be tedious to deſcend too far into Particulars, to reckon up the many Benefits of this noble Appendage of our Globe in many uſeful Engines (*k*); in many of the Functions and Operations

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Weight. Now the Rule de inſidentibus humido *is, That a Body that is heavier than ſo much Water, as is equal in Quantity to the Bulk of it, will ſink; a Body that is lighter will ſwim; a Body of equal Weight will reſt in any Part of the Water. By this Rule, if the Fiſh, in the middle Region of the Water, be of equal Weight to the Water, that is, commenſurate to the Bulk of it, the Fiſh will reſt there, without any Tendency upwards or downwards; And if the Fiſh be deeper in the Water, the Bulk of the Fiſh becoming leſs by the Compreſſion of the Bladder, and yet retaining the ſame Weight, it will ſink, and reſt at the Bottom. And on the other Side, if the Fiſh be higher than the middle Region, the Air dilating itſelf, and the Bulk of the Fiſh conſequently increaſing, but not the Weight, the Fiſh will riſe upwards, and reſt at the Top of the Water. Perhaps, the Fiſh, by ſome Action, can emit Air out of its Bladder—; and, when not enough, take in Air,—and then it will not be wondered, that there ſhould be always a fit Proportion of Air in all Fiſhes to ſerve their Uſe,* &c. Then follows a Method of Mr. *Boyle*'s to experiment the Truth of this. After which, in Mr. *Lowthorp*'s Abridgment, follow Mr. *Ray*'s Obſervations. *I think that —— hath hit upon the true Uſe of the Swimming-Bladders in Fiſhes. For,* 1. *It hath been obſerved, that if the Swimming-Bladder of any Fiſh be pricked or broken, ſuch a Fiſh ſinks preſently to the Bottom, and can neither ſupport or raiſe itſelf up in the Water.* 2. *Flat Fiſhes, as Soles, Plaiſe,* &c. *which lie always grovelling at the Bottom, have no Swimming-Bladders that ever I could find.* 3. *In moſt Fiſhes there is a manifeſt Channel leading from the Gullet — to the ſaid Bladder, which, without Doubt, ſerves for the conveying Air thereunto. — In the Coat of this Bladder is a muſculous Power to contract it when the Fiſh liſts.* See more very curious Obſervations relating to this Matter, of the late great Mr. *Ray*, as alſo of the curious anonymous Gentleman, in the ingenious Mr. *Lowthorp*'s Abridgment before cited, *p.* 845. from *Philoſoph. Tranſact.* Nº 114, 115.

(*k*) Among the Engines in which the Air is uſeful, Pumps may be accounted not contemptible ones, and divers other Hydraulical Engines, which need not to be particularly inſiſted on. In theſe the Water was imagined to riſe by the Power of Suction, to avoid a *Vacuum*, and ſuch unintelligible Stuff; but the juſtly famous Mr. *Boyle* was the firſt that ſolved theſe Phænomena by the weight of the Atmoſphere. His ingenious and curious tions of Nature (*l*) in the Conveyance of Sounds; and a thouſand Things beſides. And I ſhall but juſt mention the admirable Uſe of our Atmoſphere in miniſtring to the enlightening of the World, by its reflecting the Light of the heavenly Bodies to us (*m*); and refracting the Sun-beams to our Eye, before

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curious Obſervations and Experiments relating hereto, may be ſeen in his little Tract, *Of the Cauſe of Attraction by Suction,* and divers others of his Tracts.

(*l*) It would be endleſs to ſpecify the Uſes of the Air in Nature's Operations: I ſhall therefore, for a Sample only, name its great Uſe to the World in conſerving animated Bodies, whether endowed with animal or vegetative Life, and its contrary Quality of diſſolving other Bodies; by which means many Bodies that would prove Nuiſances to the World, are put out of the Way, by being reduced into their firſt Principles (as we ſay) and ſo embodied with the Earth again. Of its Faculty as a Menſtruum, or its Power to diſſolve Bodies, I may inſtance in Chryſtal Glaſſes; which, with long keeping, eſpecially if not uſed, will in Time be reduced to a Powder, as I have ſeen. So divers Minerals, Earths, Stones, Foſſil-Shells, Wood, &c. which from *Noah*'s Flood, at leaſt for many Ages, have lain under Ground, ſo ſecure from Corruption, that, on the contrary, they have been thereby made much the ſtronger, have in the open Air ſoon mouldered away. Of which laſt Mr. *Boyle* gives an Inſtance (from the *Diſſertatio de admirandis Hungar. Aquis*) of a great Oak, like a huge Beam, dug out of a Salt Mine in *Tranſylvania, ſo hard, that it would not eaſily be wrought upon by Iron Tools, yet being expoſed to the Air out of the Mine, it became ſo rotten, that in four Days it was eaſy to be broken, and crumbled between one's Fingers.* Boyle's Suſpic. about ſome hidden Qualities in the Air, *p.* 28. So the Trees turned out of the Earth by the Breaches at *Weſt-Thurrock* and *Dagenham,* near me, although probably no other than *Alder,* and interred many Ages ago in a rotten ouzy Mould, were ſo exceedingly tough, hard, and ſound at firſt, that I could make but litle Impreſſions on them with the Strokes of an Ax; but being expoſed to the Air and Water, ſoon became ſo rotten as to be crumbled between the Fingers. See my Obſervations in *Philoſ. Tranſact.* Nº 335.

(*m*) *By reflecting the Light of the heavenly Bodies to us,* I mean that Whiteneſs or Lightneſs which is in the Air in the Day-time, cauſed by the Rays of Light ſtriking upon the Particles of the Atmoſphere, as well as upon the Clouds above, and the other Objects beneath upon the Earth. To the ſame Cauſe fore it ever ſurmounteth our Horizon (*n*); by which means the Day is protracted throughout the whole Globe; and the long and diſmal Nights are ſhorten'd in the frigid Zones, and Day ſooner approacheth them; yea, the Sun itſelf riſeth in Ap-

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Cauſe alſo we owe the Twilight, *viz.* to the Sun-beams touching the uppermoſt Particles of our Atmoſphere, which they do when the Sun is about eighteen Degrees beneath the Horizon. And as the Beams reach more and more of the airy Particles, ſo Darkneſs goes off, and Daylight comes on and increaſeth. For an Exemplification of this, the Experiment may ſerve of tranſmitting a few Rays of the Sun through a ſmall Hole into a dark Room: by which means the Rays which meet with Duſt, and other Particles flying in the Air, are rendered viſible; or (which amounts to the ſame) thoſe ſwimming ſmall Bodies are rendered viſible, by their reflecting the Light of the Sun-beams to the Eye, which, without ſuch Reflection, would itſelf be inviſible.

The Azure Colour of the Sky Sir *Iſaac Newton* attributes to Vapours beginning to condenſe, and that are not able to reflect the other Colours. *Vide Optic.* lib. ii. par. 3. prop. 7.

(*n*) By the refractive Power of the Air, the Sun and the other heavenly Bodies ſeem higher than really they are, eſpecially near the Horizon. What the Refractions amount unto, what Variations they have, and what Alterations in Time they cauſe, may be briefly ſeen in a little Book called *The Artificial Clock-maker*, chap. 11.

Although this inflective Quality of the Air be a great Incumbrance and Confuſion of Aſtronomical Obſervations; — yet it is not without ſome conſiderable Benefit to Navigation; and indeed in ſome Caſes, the Benefit thereby obtained is much greater than would be the Benefit of having the Ray proceed in an exact ſtraight Line. [Then he mentions the Benefit hereof to the Polar Parts of the World.] *But this by the bye* (ſaith he.) *The great Advantage I conſider therein, is the firſt Diſcovery of Land upon the Sea; for by Means hereof, the Tops of Hills and Lands are raiſed up into the Air, ſo as to be diſcoverable ſeveral Leagues farther off on the Sea than they would be, were there no ſuch Refraction, which is of great Benefit to Navigation for ſteering their Courſe in the Night, when they approach near Land; and likewiſe for directing them in the Day-time, much more certainly than the moſt exact Celeſtial Obſervations could do by the Help of an uninflected Ray, eſpecially in ſuch Places as they have no Soundings.* [Then he propoſes a Method to find, by theſe Means, the Diſtance of Objects at Sea.] *Vide Dr.* Hook's *Poſt. Works, Lect. of Navig. p.* 466.

pearance (when really it is abſent from them) to the great Comfort of thoſe forlorn Places *(o)*.

But paſſing by all theſe Things with only a bare Mention, and wholly omitting others that might have been named, I ſhall only inſiſt upon the excellent Uſe of this noble circumambient Companion of our Globe, in reſpect of two of its Meteors, the Winds, and the Clouds and Rain *(p)*.

(o) Cum Belgæ in Novâ Zemblâ hybernarent, Sol illis apparuit 16 *diebus citiùs quàm revera in Horizonte exiſteret, hoc eſt, cùm adhuc infra Horizontem depreſſus eſſet quatuor circiter gradibus, & quidem aere ſereno.* Varen. Geog. cap. xix. prop. 22.

[Theſe Hollanders] *found, that the Night in that Place ſhortened no leſs than a whole Month; which muſt needs be a very great Comfort to all ſuch Places as live very far towards the North and South Poles, where Length of Night, and Want of ſeeing the Sun, cannot chuſe but be very tedious and irkſome.* Hook, ibid.

[By means of the Refractions] *we found the Sun to riſe twenty Minutes before it ſhould; and in the Evening to remain above the Horizon twenty Minutes (or thereabouts) longer than it ſhould.* Capt. *James*'s Journ. in *Boyle* of Cold. Tit. 18. p. 190.

(p) Aer in Nubes cogitur: humoremque colligens terram auget imbribus: tum effluens huc & illuc, ventos efficit. Idem annuas frigorum, & calorum facit varietates: idemque & volatus Alitum ſuſtinet, & ſpiritu ductus alit & ſuſtentat animantes. Cic. de Nat. Deor. lib. ii. cap. 39.

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CHAP. II.

Of the Winds (a).

TO paſs by other Conſiderations, whereby I might demonſtrate the Winds to be the infinite Creator's Contrivance, I ſhall inſiſt only upon their great Uſefulneſs to the World. And ſo great is

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(a) *Ventus eſt aer fluens*, is *Seneca's* Definition. *Na. Qu.* *l.* v. And as Wind is a Current of the Air, ſo that which excites or alters its Currents, may be juſtly ſaid to be the Cauſe of the Winds. An Æquipoiſe of the Atmoſphere produceth a Calm; but if that Æquipoiſe be more or leſs taken off, a Stream of Air, or Wind, is thereby accordingly produced, either ſtronger or weaker, ſwifter or ſlower. And divers Things there are, that may make ſuch Alterations in the Æquipoiſe or Balance of the Atmoſphere, *viz.* Eruptions of Vapours from Sea or Land; Rarefactions and Condenſations in one Place more than another; the Falling of Rain, Preſſure of the Clouds, &c. *Pliny*, lib. ii. cap. 45. tells us of a certain *Cavern* in *Dalmatia*, called *Senta*, *in quem*, ſaith he, *dejecto levi pondere, quamvis tranquillo die, turbini ſimilis emicat procella.* But as to Caves, it is obſerved, that they often emit Winds, more or leſs. Dr. *Connor*, taking Notice of this Matter, ſpecifies theſe, *In regno Neapolitano ex immani Cumanæ Sibyllæ antro tenuem ventum effluentem percepi.* The like he obſerved at the Caves at *Baia*, and in ſome of the Mines of *Germany*, and in the large Salt-Mines of *Cracow* in *Poland*. *Ubi*, ſaith he, *opifices, & ipſe fodinæ dominus Andreas Morſtin, Nob. Polonus, mihi aſſeruerunt, quòd tanta aliquando Ventorum tempeſtas ex ambagioſis hujus fodinæ receſſibus ſurgere ſolebat, quod laborantes foſſores humi proſternebat, nec non portas & domicilia (quæ ſibi in hâc fodinâ artifices extruunt) penitùs evertebat.* Bern. Connor. Diſſer. Med. Phyſ. p. 33. Art. 3. And as great Caves, ſo great Lakes ſometimes ſend forth Winds. So *Gaſſendus* ſaith the *Lacus Legnius* doth, *E quo dum exoritur fumus, nubes haud dubie creanda eſt, quæ ſit brevi in tempeſtatem ſæviſſimam exoneranda.* Gaſſend. Vit. Peireſk. lib. v. p. 417.

But

is their Uſe, and of ſuch abſolute Neceſſity are they to the Salubrity of the Atmoſphere, that all the World

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But the moſt univerſal and conſtant Alterations of the Balance of the Atmoſphere, are from Heat and Cold. This is manifeſt in the general Trade-Winds, blowing all the Year between the Tropicks from Eaſt to Weſt: If the Cauſe thereof be (as ſome ingenious Men imagine) the Sun's daily Progreſs round that Part of the Globe, and by his Heat rarefying one Part of the Air, whilſt the cooler and heavier Air behind preſſeth after. So the Sea and Land Breezes in Note *d*. And ſo in our Climate, the Northerly and Southerly Winds (commonly eſteemed the Cauſes of cold and warm Weather,) are really the Effects of the Cold or Warmth of the Atmoſphere: Of which I have had ſo many Confirmations, that I have no Doubt of it. As, for Inſtance, it is not uncommon to ſee a warm Southerly Wind ſuddenly changed to the North, by the Fall of Snow or Hail; to ſee the Wind in a froſty, cold Morning, North, and when the Sun hath well warmed the Earth and Air, you may obſerve it to wheel about towards the Southerly Quarters: and again to turn Northerly or Eaſterly in the cold Evening. It is from hence alſo, that in Thunder-Showers the Wind and Clouds are oftentimes contrary to one another, (eſpecially if Hail falls) the ſultry Weather below directing the Wind one Way, and the Cold above the Clouds another Way. I took Notice upon *March* the 10th, 1710-11, (and divers ſuch like Inſtances I have had before and ſince) that the Morning was warm, and what Wind ſtirred was Weſt-South-weſt, but the Clouds were thick and black (as generally they are when Snow enſues:) A little before Noon the Wind veered about to North by Weſt, and ſometimes to other Points, the Clouds at the ſame Time flying ſome North by Weſt, but ſome South-Weſt: About One of the Clock it rained apace, the Clouds flying ſometimes North-Eaſt, then North, and at laſt both Wind and Clouds ſettled North by Weſt; at which Time Sleet fell plentifully, and it grew very cold. From all which I obſerve, 1. That although our Region below was warm, the Region of the Clouds was cold, as the black, ſnowy Clouds ſhewed. 2. That the Struggle between the Warmth of ours, and the Cold of the cloudy Region, ſtopped the airy Currents of both Regions. 3. That the Falling of the Snow through our warmer Air melted into Rain at firſt; but that it became Sleet after the ſuperior Cold had conquered the inferior Warmth. 4. That, as that Cold prevailed by Degrees, ſo by Degrees it wheeled about both the Winds and Clouds from the Northwards towards the South.

Hippocrates,

World would be poiſoned without thoſe Agitations thereof. We find how putrid, fetid, and unfit for Reſpiration, as well as Health and Pleaſure, a ſtagnating, confined, pent-up Air is. And if the whole Maſs of Air and Vapours was always at Reſt, and without Motion, inſtead of refreſhing and animating, it would ſuffocate, and poiſon all the World: But the perpetual Commotions it receives from the Gales and Storms, keep it pure and healthful *(b)*.

Neither are thoſe Ventilations beneficial only to the Health, but to the Pleaſure alſo of the Inhabitants of the Terraqueous Globe; witneſs the Gales which fan us in the Heat of Summer; without which, even in this our temperate Zone, Men are ſcarce able to perform the Labours of their Calling, or

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Hippocrates, lib. ii. *De Vict. Orat. Omnes Ventos vel à nive, glacie, vehementi gelu, fluminibus, &c. ſpirare neceſſe judicat.* Bartholin. de uſu Nivis, cap. 1.

(b) It is well obſerved in my Lord Howard's *Voyage to* Conſtantinople, *That at* Vienna *they have frequent Winds, which if they ceaſe long in Summer, the Plague often enſues: So that it is now grown into a Proverb, That if* Auſtria *be not windy, it is ſubject to Contagion.* Bohun of Wind, p. 213.

From ſome ſuch Commotions of the Air I imagine it is, that at *Grand Cairo* the Plague immediately ceaſes, as ſoon as the *Nile* begins to overflow; although Mr. *Boyle* attributes it to nitrous Corpuſcles. *Determ. Nat. of Effluv.* chap. 4.

Nulla enim propemodum regio eſt, quæ non habeat aliquem flatum ex ſe naſcentem, & circa ſe cadentem.

Inter cætera itaque Providentiæ opera, hoc quoque aliquis, ut dignum admiratione ſuſpexerit. Non enim ex unâ cauſâ Ventos aut invenit, aut per diverſa diſpoſuit: ſed primum ut aera non ſinerent pigreſcere, ſed aſſiduâ vexatione utilem redderent, vitalemque tracturis. Sen. Nat. Queſt. lib. v. cap. 17, 18.

All this is more evident from the Cauſe aſſigned to malignant epidemical Diſeaſes, particularly the Plague, by my ingenious learned Friend, Dr. *Mead*; and that is, an hot and moiſt Temperament of the Air, which is obſerved by *Hippocrates, Galen*, and the general Hiſtories of Epidemical Diſeaſes, to attend thoſe Diſtempers. *Vide* Mead *of Poiſons, Eſſay* 5. p. 161. But indeed, whether the Cauſe be this, or poiſonous, malignant Exhalations, or Animalcules, as others think, the or not without Danger of Health and Life (c). But eſpecially, witneſs the perpetual Gales which through-

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the Winds are however very ſalutiferous in ſuch Caſes, in cooling the Air, and diſperſing and driving away the moiſt or peſtiferous Vapours.

(c) *July* 8, 1707, (called for ſome time after the *Hot Tueſday*,) was ſo exceſſively hot and ſuffocating, by reaſon there was no Wind ſtirring, that divers Perſons died, or were in great Danger of Death, in their Harveſt-Work. Particularly one who had formerly been my Servant, a healthy, luſty, young Man, was killed by the Heat; and ſeveral Horſes on the Road dropped down and died the ſame Day.

In the foregoing Notes having taken Notice of ſome Things relating to Heat, although it be ſomewhat out of the way, I hope the Reader will excuſe me, if I entertain him with ſome Obſervations I made about the Heat of the Air under the Line, compared with the Heat of our Bodies. *J. Patrick*, who, as he is very accurate in making Barometrical and Thermometrical Inſtruments, had the Curioſity, for the nicer adjuſting his Thermometers, to ſend two abroad (under the Care of two very ſenſible ingenious Men) one to the Northern Latitude of 81; the other to the Parts under the Æquinoctial: In theſe two different Climates, the Places were marked where the Spirits ſtood at the ſevereſt Cold and greateſt Heat. And according to theſe Obſervations he graduates his Thermometers. With his Standard I compared my Standard Thermometer, from all the Degrees of Cold, I could make with *Sal Armoniack*, &c. to the greateſt Degree of Heat our Thermometers would reach to. And with the ſame Thermometer (of mine) I experimented the greateſt Heat of my Body, in *July*, 1709. Firſt in an hot Day without Exerciſe, by putting the Ball of my Thermometer under my Armpits, and other hotteſt Parts of my Body. By which means the Spirits were raiſed 284 Tenths of an Inch above the Ball. After that, in a much hotter Day, and indeed nearly as hot as any Day with us, and after I had heated myſelf with ſtrong Exerciſe too, as much as I could well bear, I again tried the ſame Experiment, but could not get the Spirits above 288 Tenths; which I thought an inconſiderable Difference for ſo ſeemingly a very different Heat of my Body. But from ſome Experiments I have made (although I have unfortunately forgotten them) in very cold Weather, I imagine the Heat of an healthy Body to be always much the ſame in the warmeſt Parts thereof, both in Summer and Winter. Now between thoſe very Degrees of 284, and 288, the Point of the Equatorial Heat falleth. From which Obſervation it appears, that there is pretty nearly an equal Contemperamen throughout the whole Year do fan the Torrid Zone; and make that Climate an healthful and pleaſant Habitation, which would otherwiſe be ſcarce habitable.

To theſe I might add many other great Conveniencies of the Winds in various Engines, and various Buſineſſes. I might particularly inſiſt upon its great Uſe to tranſport Men to the fartheſt diſtant Regions of the World; (*d*) and I might particularly ſpeak of the general and coaſting Trade-Winds, the Sea, and the Land-Breezes; (*e*) the one ſerving

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perament of the Warmth of our Bodies, to that of the hotteſt Part of the Atmoſphere inhabited by us.

If the Proportion of the Degrees of Heat be deſired from the Freezing Point, to the Winter, Spring, and Summer Air, the Heat of Man's Body, of heated Water, melted Metals, and ſo to actual Fire; an Account may be met with of it, by my moſt ingenious Friend, the great Sir *Iſaac Newton*, in *Philoſ. Tranſact.* N°. 270.

(*d*) *In hoc* Providentia *ac* Diſpoſitor *ille Mundi* Deus, *aera ventis exercendum dedit, — non ut nos claſſes partem freti occupaturas compleremus milite armato, &c. Dedit ille ventos ad cuſtodiendam cœli terrarumque temperiem, ad evocandas ſupprimendaſque aquas, ad alendos ſatorum atque arborum fructus; quos ad maturitatem cum aliis cauſis adducit ipſa jactatio, attrahens cibum in ſumma, & ne torpeat, promovens. Dedit ventos ad ulteriora noſcenda: fuiſſet enim imperitum animal, & ſine magnâ experientiâ rerum Homo, ſi circumſcriberetur natalis ſoli fine. Dedit ventos ut commoda cujuſque regionis fierent communia; non ut legiones equitemque geſtarent, nec ut pernicioſa gentibus arma tranſveherent.* Seneca, ibid.

(*e*) Sea Breezes *commonly riſe in the Morning about Nine o' Clock. — They firſt approach the Shore gently, as if they were afraid to come near it. — It comes in a fine, ſmall, black Curle upon the Water, whereas all the Sea between it and the Shore (not yet reached by it) is as ſmooth and even as Glaſs in Compariſon. In half an Hour's time after it has reached the Shore, it fans pretty briſkly, and ſo increaſeth gradually till Twelve o' Clock; then it is commonly the ſtrongeſt, and laſts ſo till Two or Three, a very briſk Gale. — After Three it begins to die away again, and gradually withdraws its Force till all is ſpent; and about Five o' Clock — it is lulled aſleep, and comes no more till next Morning.*

And

to carry the Mariner in long Voyages from Eaſt to Weſt; the other ſerving to waft him to particular Places; the one ſerving to carry him into his Harbour, the other to bring him out. But I ſhould go too far to take Notice of all Particulars (ſ). Leaving therefore the Winds, I proceed, in the next Place, to the Clouds and Rain.

And as the Sea-Breezes do blow in the Day, and reſt in the Night; ſo on the contrary [the Land-Breezes] *blow in the Night, and reſt in the Day, alternately ſucceeding each other.—They ſpring up between Six and Twelve at Night, and laſt till Six, Eight, or Ten in the Morning.* Dampier's Diſc. of Winds. chap. 4.

(ſ) One thing more I believe ſome of my Friends will expect from me is, That I ſhew the Reſult of comparing my own Obſervations of the Winds, with others they know I have from *Ireland, Switzerland, Italy, France, New-England,* and ſome of our Parts of *England.* But the Obſervations being, ſome of them, but of one Year, and moſt of the reſt of but a few Years, I have not been able to determine any great Matters. The chief of what I have obſerved is, That the Winds in all theſe Places ſeldom agree; but when they moſt certainly do ſo, it is commonly when the Winds are ſtrong, and of long Continuance in the ſame Quarter: And more, I think, in the Northerly and Eaſterly than other Points. Alſo, a ſtrong Wind in one Place, is oftentimes a weak one in another Place, or moderate, according as Places have been nearer or farther diſtant. *Vide Phil. Tranſact.* N° 297, and 321. But to give a good and tolerable Account of this, or any other of the Weather, it is neceſſary to have good Hiſtories thereof from all Parts; which as yet we have but few of, and they imperfect, for Want of longer and ſufficient Obſervations.

CHAP. III.

Of the Clouds and Rain.

THE Clouds and Rain (*a*) we ſhall find to be no leſs uſeful Meteors than the laſt mentioned; as is manifeſt in the refreſhing pleaſant Shades which the Clouds afford, and the fertile Dews and Showers

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(*a*) Clouds and Rain are made of Vapours raiſed from Water or Moiſture only. So that I utterly exclude the Notion of Dry, Terrene Exhalations, or Fumes, talked much of by moſt Philoſophers; Fumes being really no other than the humid Parts of Bodies reſpectively Dry.

Theſe Vapours are demonſtratively no other than ſmall Bubbles, or Veſiculæ, detached from the Waters by the Power of the Solar, or Subterraneous Heat, or both. Of which ſee *Book* ii. *Chap*. 5, *Note (b)*. And being lighter than the Atmoſphere, are buoyed up thereby, until they become of an equal Weight therewith, in ſome of its Regions aloft in the Air, or nearer the Earth; in which thoſe Vapours are formed into Clouds, Rain, Snow, Hail, Lightning, Dew, Miſts, and other Meteors.

In this Formation of Meteors the grand Agent is Cold, which commonly, if not always, occupies the ſuperior Regions of the Air; as is manifeſt from thoſe Mountains which exalt their lofty Tops into the upper and middle Regions, and are always covered with Snow and Ice.

This Cold, if it approaches near the Earth, preſently precipitates the Vapours, either in *Dews*; or if the Vapours more copiouſly aſcend, and ſoon meet the Cold, they are then condenſed into *Miſling*, or elſe into Showers of *ſmall Rain*, falling in numerous, thick, ſmall Drops: But if thoſe Vapours are not only copious, but alſo as heavy as our lower Air itſelf (by means their Bladders are thick and fuller of Water), in this caſe they become viſible, ſwim but a little Height above the Earth, and make what we call a *Miſt* or *Fog*. But if they are a Degree lighter, ſo as to mount higher, but not any great Height, Showers which they pour down on the Trees and Plants, which would languiſh and die with perpe-

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Height, as alſo meet not with Cold enough to condenſe them, nor Wind to diſſipate them, they then form an heavy, thick, *dark Sky*, laſting oftentimes for ſeveral Weeks without either Sun or Rain. And in this Caſe I have ſcarce ever known it to Rain, till it hath been *firſt Fair, and then Foul.* And Mr. *Clarke* (an ingenious Clergyman of *Norfolk*), who in his Life-time, long before me, took notice of it, and kept a Regiſter of the Weather for thirty Years, which his learned Grandſon, Dr. *Samuel Clarke*, put into my Hands, he (I ſay) ſaith, he ſcarce ever obſerved the Rule to fail in all that Time; only he adds, *If the Winds be in ſome of the Eaſterly Points.* But I have obſerved the ſame to happen, be the Wind where it will. And from what hath been ſaid, the Caſe is eaſily accounted for, *viz.* whilſt the Vapours remain in the ſame State, the Weather doth ſo too. And ſuch Weather is generally attended with moderate Warmth, and with little or no Wind to diſturb the Vapours, and an heavy Atmoſphere to ſupport them, the Barometer being commonly high then. But when the Cold approacheth, and by condenſing drives the Vapours into Clouds or Drops, then is Way made for the Sun-beams, till the ſame Vapours, being by farther Condenſation formed into Rain, fall down in Drops.

The Cold's approaching the Vapours, and conſequently the Alteration of ſuch dark Weather, I have beforehand perceived, by ſome few ſmall Drops of Rain, Hail, or Snow, now and then falling, before any Alteration hath been in the Weather; which I take to be from the Cold meeting ſome of the ſtraggling Vapours, or the uppermoſt of them, and condenſing them into Drops, before it arrives unto, and exerts itſelf upon the main Body of Vapours below.

I have more largely than ordinary inſiſted upon this part of the Weather, partly as being ſomewhat out of the Way; but chiefly, becauſe it gives Light to many other *Phænomena* of the Weather. Particularly we may hence diſcover the Original of Clouds, Rain, Hail, and Snow; that they are Vapours carried aloft by the Gravity of the Air, which meeting together ſo as to make a Fog above, they thereby form a *Cloud.* If the Cold condenſeth them into Drops, they then fall in *Rain*, if the Cold be not intenſe enough to freeze them: But if the Cold freezeth them in the Clouds, or in their Fall through the Air, they then become *Hail* or *Snow.*

As to *Lightning*, and other enkindled Vapours, I need ſay little in this Place, and ſhall therefore only obſerve, that they owe alſo their Riſe to Vapours; but ſuch Vapours as are de-

tached

tual Drought, but are hereby made Verdant and Flouriſhing, Gay and Ornamental; ſo that (as the Pſalmiſt

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tached from mineral Juices, or at leaſt that are mingled with them, and are Fired by Fermentation.

Another *Phænomenon* reſolvable from what hath been ſaid is, why a *cold* is always a *wet* Summer, *viz.* becauſe the Vapours riſing plentifully then, are by the Cold ſoon collected into Rain. A remarkable Inſtance of this we had in the Summer of 1708, Part of which, eſpecially about the *Solſtice*, was much colder than uſually. And *June* 12, it was ſo cold, that my Thermometer was near the Point of hoar Froſt, and in ſome Places I heard there was an hoar Froſt; and during all the cool Weather of that Month, we had frequent and large Rains, ſo that the whole Month's Rain amounted to above two Inches Depth, which is a large Quantity for *Upminſter*, even in the wetteſt Months. And not only with us at *Upminſter*, but in other Places, particularly at *Zurich*, in *Switzerland*, they ſeem to have had as unſeaſonable Cold and Wet as we. *Fuit hic menſis — præter modum humidus, & magno quidem vegetabilibus hominibuſque damno. Multum computruit Fœnum*, &c. complains the Induſtrious and Learned Dr. *J. J. Scheuchzer:* Of which, and other Particulars I have given a large Account in *Philoſ. Tranſact.* N° 321.

In which *Tranſaction* I have obſerved farther, that about the Equinoxes we (at *Upminſter* at leaſt) have oftentimes more Rain than at other Seaſons. The Reaſon of which is manifeſt from what hath been ſaid, *viz.* in Spring, when the Earth and Waters are looſed from the brumal Conſtipations, the Vapours ariſe in great Plenty: And the like they do in Autumn, when the Summer Heats, that both diſſipated them, and warmed the ſuperior Regions, are abated; and then the Cold of the ſuperior Regions meeting them, condenſeth them into Showers, more plentifully than at other Seaſons, when either the Vapours are fewer, or the Cold that is to condenſe them is leſs.

The Manner how Vapours are precipitated by the Cold, or reduced into Drops, I conceive to be thus: Vapours being, as I ſaid, no other than Inflated *Veſiculæ* of Water; when they meet with a colder Air than what is contained in them, the contained Air is reduced into a leſs Space, and the watry Shell or Caſe rendered thicker by that means, ſo as to become heavier than the Air, by which they are buoyed up, and conſequently muſt needs fall down. Alſo many of thoſe thickened *Veſiculæ* run into one, and ſo form Drops, greater or ſmaller, according to the Quantity of Vapours collected together.

As

Pſalmiſt ſaith, *Pſal.* lxv. 12, 13.) *The little Hills rejoice on every ſide, and the Valleys ſhout for Joy, they alſo ſing.*

And

As to the Rain of different Places, I have, in ſome of our *Tranſactions*, aſſigned the Quantities; particularly in the laſt cited *Tranſaction*, I have aſſigned theſe, *viz.* the Depth of the Rain one Year with another, in *Engliſh* Meaſure, if it was to ſtagnate on the Earth, would amount unto, at *Townly*, in *Lancaſhire*, 42 Inches and a half; at *Upminſter* in *Eſſex*, 19 Inches and a quarter; at *Zurich* in *Switzerland*, 32 Inches and a quarter; at *Piſa* in *Italy*, 43 Inches and a quarter; at *Paris* in *France*, 19 Inches; and at *Liſle* in *Flanders* 24 Inches.

It would be endleſs to reckon up the *bloody* and other *prodigious Rains* taken notice of by Hiſtorians, and other Authors, as præternatural and ominous Accidents; but if ſtrictly pried into, will be found owing to natural Cauſes: Of which, for the Reader's Satisfaction, I will give an Inſtance or two. A Bloody Rain was imagined to have fallen in *France*, which put the Country People into ſo great a Fright, that they left their Work in the Fields, and in great Haſte flew to the neighbouring Houſes. *Peireſc* (then in the Neighbourhood) ſtrictly inquiring into the Cauſe, found it to be only red Drops coming from a ſort of Butterfly that flew about in great Numbers at that Time, as he concluded from ſeeing ſuch red Drops to come from them; and becauſe theſe Drops were laid, *Non ſupra ædificia, non in devexis lapidum ſuperficiebus, uti debuerat contingere, ſi è cælo ſanguine pluiſſet; ſed in ſubcavis potius & in foraminibus. — Acceſſit, quòd parietes iis tingebantur, non qui in mediis oppidis, ſed qui agrorum vicini erant, neque ſecundum partes elatiores, ſed ad mediocrem ſolum altitudinem, quantam volitare Papiliones ſolent.* Gaſſend. in vit. Peireſk, lib. ii. p. 156.

So Dr. *Merret* ſaith alſo, *Pluvia Sanguinis quàm certiſſime conſtat eſſe tantùm Inſectorum excrementa; Pluvia Tritici quàm nihil aliud eſſe quàm Hederæ bacciferæ grana à Sturnis devorata excretaque comparanti liquidiſſimè patet.* Pinax rerum, &c. p. 220.

The curious *Worm* tells us of the raining of Brimſtone, *An.* 1646, *Maii* 16. *Hìc Hafniæ cùm ingenti pluviâ tota urbs, omneſque ita inundarentur plateæ, ut greſſus hominum impediret, Sulphureoque odore aërem inficeret, dilapſis aliquantulum aquis, quibuſdam in locis colligere licuit Sulphureum pulverem, cujus portionem ſervo, colore, odore, & aliis verum Sulphur ferentem,* Muſ. Worm. lib. i. cap. 11. ſect. 1.

Together with the Rain we might take notice of other Meteors, particularly *Snow*; which although an irkſome Gueſt, yet hath its great Uſes, if all be true that the famous *T. Bar-*

And if to theſe Uſes, we ſhould add the Origin of Fountains and Rivers, to Vapours and the Rains,

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tholin ſaith of it, who wrote a Book *de Nivis Uſu Medico.* In which he ſhews of what great Uſe Snow is, in fructifying the Earth, preſerving from the Plague, curing Fevers, Cholicks, Head-Aches, Tooth-Aches, Sore Eyes, Pleuriſies (for which Uſe, he ſaith, his Country Women of *Denmark* keep Snow-Water gathered in *March),* alſo in prolonging Life (of which he inſtanceth in the *Alpine* Inhabitants, that live to a great Age), and preſerving dead Bodies; Inſtances of which he gives in Perſons buried under the Snow in paſſing the *Alps,* which are found uncorrupted in the Summer, when the Snow is melted; which ſad Spectacle he himſelf was an Eye-Witneſs of. And at *Spitzberg* in *Greenland,* dead Bodies remain entire and uncorrupted for thirty Years. And laſtly, concerning ſuch as are ſo preſerved when ſlain, he ſaith they remain in the ſame Poſture and Figure: Of which he gives this odd Example. *Viſum id extra urbem noſtram* [Hafniam] *quum,* 11 *Feb.* 1659. *oppugnantes hoſtes repellerentur, magnâque ſtrage occumberent; alii enim rigidi iratum vultum oſtendebant, alii oculos elatos; alii ore diducto ringentes, alii brachiis extenſis Gladium minari, alii alio ſitu proſtrati jacebant.* Barthol. de Uſu Niv. cap. 12.

But although Snow be attended with the Effects here named, and others ſpecified by the learned *Bartholin*; yet this is not to be attributed to any peculiar Virtue in the Snow, but ſome other Cauſe. Thus when it is ſaid to *fructify the Earth,* it doth ſo by guarding the Corn or other Vegetables againſt the intenſer Cold of the Air, eſpecially the cold piercing Winds; which the Huſbandmen obſerve to be moſt injurious to their Corn, of all Weathers. So for *Conſerving dead Bodies,* it doth it by conſtipating ſuch Bodies, and preventing all ſuch Fermentations or internal Conflicts of their Particles, as would produce Corruption.

Such an Example as the preceding is ſaid to have happened ſome Years ago at *Paris,* in digging in a Cellar for ſuppoſed hidden Treaſure; in which, after digging ſome Hours, the Maid, going to call her Maſter, found them all in their digging Poſtures, but dead. This being noiſed abroad, brought in not only the People, but Magiſtrates alſo, who found them accordingly; *Ille qui ligone terram effoderat, & ſocius qui palâ effoſſam terram removerat, ambo pedibus ſtabant, quaſi ſuo quiſque operi affixus incubuiſſet; uxor unius quaſi ab opere defeſſa in ſcamno, ſolicito quodam vultu, ſedebat, inclinato in palmam manûs genibus innitentis capite; puerulus, laxatis braccis in margine excavatæ foveæ defixis in terram oculis alvum exonerabat; omnes in naturali ſitu,*

Rains, as ſome of the moſt eminent modern Philoſophers (*b*) have done, we ſhould have another Inſtance of the great Uſe and Benefit of that Meteor.

And now, if we reflect upon this neceſſary Appendage of the Terraqueous Globe, the *Atmoſphere*; and conſider the abſolute Neceſſity thereof to many Uſes of our Globe, and its great Convenience to the Whole: And in a word, that it anſwereth all the Ends and Purpoſes that we can ſuppoſe there can be for ſuch an Appendage: Who can but own this to be the Contrivance, the Work of the great Creator? Who would ever ſay or imagine ſuch a Body, ſo different from the Globe it ſerves, could be made by Chance, or be adapted ſo exactly to all thoſe forementioned grand Ends, by any other Efficient than by the Power and Wiſdom of the infinite God! Who would not rather, from ſo noble a Work, readily acknowledge the Workman (*c*), and as eaſily

conclude

ſitu, corneæ tanquam ſtatuæ rigidi, apertis oculis & vultu vitam quaſi reſpirante, exanimes ſtabant. Dr. Bern. Connor, Diſſert. Med. Phyſ. *p.* 15.

The Doctor attributes all this to Cold; but I ſcarce think there could be Cold enough to do all this at *Paris*, and in a Cellar too. But his following Stories are not improbable, of Men and Cattle killed with Cold, that remained in the very ſame Poſture in which they died; of which he gives, from a *Spaniſh* Captain, this Inſtance, that happened two Years before, of a Soldier who unfortunately ſtraggled from his Company that were foraging, and was killed with the Cold, but was thought to have fallen into the Enemies Hands. But ſoon after their Return to their Quarters, they ſaw their Comrade returning, ſitting on Horſeback, and coming to congratulate him, found him dead, and that he had been brought thither in the ſame Poſture on Horſeback, notwithſtanding the jolting of the Horſe. *Ibid. p.* 18.

(*b*) Of this Opinion was my late moſt ingenious and learned Friend, Mr. *Ray*, whoſe Reaſons ſee in his *Phyſico-Theolog. Diſcourſes*, Diſc. II. ch. ii. p. 89, &c. So alſo my no leſs learned and ingenious Friends, Dr. *Halley*, and the late Dr. *Hook*, many of the *French* Virtuoſos alſo, and divers other very conſiderable Men before them, too many to be ſpecified here.

(*c*) *An Polycletum quidem admirabimur propter partium Statuæ*

— *conveni-*

conclude the Atmoſphere to be made by GOD, as an Inſtrument wrought by its Power, any Pneumatick Engine, to be contrived and made by Man!

CHAP. IV.

Of Light.

THUS much for the firſt Thing miniſtring to the Terraqueous Globe, the Atmoſphere and its Meteors; the next Appendage is *Light* (*a*) Concerning which, I have in my Survey of the Heavens (*b*) ſhewed what admirable Contrivances the infinitely wiſe Creator hath for the affording this noble, glorious,

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— *convenientiam ac proportionem? Naturam autem non modo non laudabimus, ſed omni etiam arte privabimus, quæ partium proportionem non ſolùm extrinſecus more Statuariorum, ſed in profundo etiam ſervavit? Nonne & Polycletus ipſe Naturæ eſt imitator, in quibus ſaltem eam potuit imitari? Potuit autem in ſolis externis partibus in quibus artem conſideravit.* With much more to the like Purpoſe. *Galen. de Uſ. Part.* lib. xvii. cap. 1.

(*a*) It is not worth while to enumerate the Opinions of the *Ariſtotelians*, *Carteſians*, and others, about the Nature of Light, *Ariſtotle* making it a Quality; *Cartes*, a Pulſion or Motion of the Globules of the ſecond Element. *Vide Cartes Princip.* p. 3. ſect. 55, &c. But, with the Moderns, I take *Light* to conſiſt of material Particles, propagated from the Sun, and other luminous Bodies, not inſtantaneouſly, but in Time, according to the Notes following in this Chapter. But not to inſiſt upon other Arguments for the Proof of it, our noble Founder hath proved the Materiality of Light and Heat, from actual Experiments on Silver, Copper, Tin, Lead, Spelter, Iron, Tutenage, and other Bodies, expoſed (both naked and cloſely ſhut up) to the Fire: All which were conſtantly found to receive an Increment of Weight. I wiſh he could have met with a favourable Seaſon to have tried his Experiments with the Sun-Beams, as he intended. *Vide* Boyle's *Exp. to make Fire and Flame ponderable.*

(*b*) Aſtro-Theol. Book vii.

rious, and comfortable Benefit to other Globes, as well as ours; the Proviſion he hath made by Moons, as well as by the Sun, for the Communication of it.

And now let us briefly conſider the great Neceſſity and Uſe thereof to all our animal World. And this we ſhall find to be little leſs than the very Life and Pleaſure of all thoſe Creatures. For what Benefit would Life be of, what Pleaſure, what Comfort would it be for us to live in perpetual Darkneſs? How could we provide ourſelves with Food and Neceſſaries? How could we go about the leaſt Buſineſs, correſpond with one another, or be of any Uſe in the World, or any Creatures be the ſame to us, without Light, and thoſe admirable Organs of the Body, which the Great *Creator* hath adapted to the Perception of that great Benefit?

But now by the Help of this admirable, this firſt made *(c)*, becauſe moſt neceſſary, Creature of God; by this, I ſay, all the animal World is enabled to go here and there, as their Occaſions call; they can tranſact their Buſineſs by Day, and refreſh and recruit themſelves by Night, with Reſt and Sleep. They can with Admiration and Pleaſure, behold the glorious Works of God; they can view the Glories of the Heavens, and ſee the Beauties of the flowry Fields, the gay Attire of the feather'd Tribe, the exquiſite Garniture of many Quadrupeds, Inſects, and other Creatures; they can take in the delightſome Landſkips of divers Countries and Places; they can with Admiration ſee the Great Creator's wonderful Art and Contrivance in the Parts of Animals, and Vegetables: And, in a Word, behold the Harmony of this lower World, and of the Globes above, and ſurvey GOD's exquiſite Workmanſhip in every Creature.

(c) *And God ſaid, Let there be Light, and there was Light.* Gen. i. 3.

To all which I might add the Improvements which the Sagacity of Men hath made of this noble Creature of God, by the Refractions and Reflections of Glaſſes. But it would be endleſs to enumerate all its particular Uſes and Benefits to our World.

But before I leave this Point, there are two Things concerning Light, which will deſerve an eſpecial Remark; and that is, its ſwift and almoſt inſtantaneous Motion, and its vaſt Extenſion.

1. It is a very great Act of the Providence of God, that ſo great a Benefit as Light is, is not long in its Paſſage from Place to Place. For was the Motion thereof no ſwifter than the Motion of the ſwifteſt Bodies on Earth, ſuch as of a Bullet out of a great Gun; or even of a Sound *(d)* (which is the ſwifteſt Motion we have next Light,) in this Caſe Light would take up, in its Progreſs from the Sun to us, above thirty two Years, at the rate of the firſt; and above ſeventeen Years, at the rate of the latter Motion.

The Inconveniencies of which would be, its Energy and Vigour would be greatly cooled and aba-

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(d) It may not be ungrateful to the Curious to take Notice of the Velocity of theſe two Things.

According to the Obſervations of *Merſennus*, a Bullet ſhot out of a great Gun, flies 92 Fathom in a Second of Time. *(Vide Merſen. Baliſt.)* which is equal to 589 *Engliſh* Feet and a half; and according to the Computation of Mr. *Huygens*, it would be 25 Years in paſſing from the Earth to the Sun. But according to my own Obſervations made with one of her late Majeſty's *Sakers*, and a very accurate Pendulum-Chronometer, a Bullet, at its firſt Diſcharge, flies 510 Yards in five half Seconds, which is a Mile in a little above 17 half Seconds. And allowing the Sun's Diſtance to be, as in the next Note, a Bullet would be 32 Years and a half in flying, with its utmoſt Velocity, to the Sun.

As to the Velocity of Sound, ſee *Book* IV. *Chap.* iii. *Note (dd)*, according to which Rate there mentioned, a Sound would be near 17 Years and a half in flying as far as the Diſtance is from the Earth to the Sun. Confer here the Experiments of the *Acad. del Ciment*, p. 140, &c.

ted; its Rays would be leſs penetrant; and Darkneſs would with greater Difficulty and much Sluggiſhneſs, be diſſipated, eſpecially by the fainter Lights of our ſublunary, luminous Bodies. But paſſing with ſuch prodigious Velocity, with nearly the inſtantaneous Swiftneſs of almoſt two hundred thouſand *Engliſh* Miles in one ſecond of Time, (*e*) or (which is the ſame thing) being but about ſeven or eight Minutes of an Hour in coming from the Sun to us, therefore with all Security and Speed, we receive the kindly Effects and Influences of that noble and uſeful Creature of God.

2. Another Thing of great Conſideration about Light is, its vaſt Expanſion, its almoſt incomprehenſible, and inconceivable Extenſion, which, as a

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(*e*) Mr. *Romer*'s ingenious Hypotheſis about the Velocity of Light, hath been eſtabliſhed by the *Royal Academy*, and in the *Obſervatory*, for eight Years, as our *Philoſ. Tranſact.* N° 136. obſerve from the *Journ. des Scavans*; our moſt eminent Aſtronomers alſo in *England* admit it: but Dr. *Hook* thinks with Monſieur *Cartes*, the Motion of Light Inſtantaneous. *Hook*'s *Poſt. Works*, p. 77. And this he endeavours to prove in p. 130, &c.

What Mr. *Romer*'s Hypotheſis is, may be ſeen in *Philoſ. Tranſact.* before-cited: As alſo in the before-mentioned Sir *Iſaac Newton*'s *Opticks*: *Light is propagated from luminous Bodies in Time, and ſpends about ſeven or eight Minutes of an Hour in paſſing from the Sun to the Earth. This was firſt obſerved by* Romer, *and then by others, by means of the Eclipſes of the Satellites of* Jupiter. *For theſe Eclipſes, when the Earth is between the* Sun *and* Jupiter, *happen about ſeven or eight Minutes ſooner than they ought to do by the Tables; and when the* Earth *is beyond the* Sun, *they happen about ſeven or eight Minutes later than they ought to do: The Reaſon being, that the Light of the Satellites hath farther to go in the latter Caſe than in the former, by the Diameter of the Earth's Orbit.* Newt. Opt. lib. ii. part 3. prop. 11.

Now foraſmuch as the Diſtance between the Sun and the Earth (according to the Computations in my *Aſtro-Theology*, *Book* I. *Chap.* iii. *Note* 2.) is 86051398 Miles; therefore, at the Rate of 7 Minutes and a half, or 450 Seconds in paſſing from the Sun, Light will be found to fly above 191225 Miles in one Second of Time.

late ingenious Author (*f*) ſaith, "Is as boundleſs and unlimited as the Univerſe itſelf, or the Expanſum of all material Beings: The Vaſtneſs of which is ſo great, that it exceeds the Comprehenſions of Man's Underſtanding. Inſomuch, that very many have aſſerted it abſolutely infinite, and without any Limits or Bounds."

And that this noble Creature of God is of this Extent, (*g*) is manifeſt from our ſeeing ſome of the fartheſt diſtant Objects, the Heavenly Bodies, ſome with our naked Eye, ſome with the Help of Opti-

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(*f*) Dr. *Hook*'s Poſthumous Works. Lect. of Light, p. 76.

(*g*) For the Proof of this vaſt Extent of Light, I ſhall take the Computation of the ſame great Man, p. 77. *If*, ſaith he, *we conſider, firſt, the vaſt Diſtance between us and the Sun, which, from the beſt and lateſt Obſervations in Aſtronomy, is judged to be about* 10000 *Diameters of the Earth, each of which is about* 7925 Engliſh *Miles; therefore the Sun's Diſtance is* 7925000 *Miles; and if we conſider, that, according to the Obſervations, which I publiſhed to prove the Motion of the Earth* [which were Obſervations of the Parallax of ſome of the fixed Stars in the Head of *Draco*, made in 1699,] *the whole Diameter of the Orb,* viz. 20000, *made the Subtenſe but of one Minute to one of the fixed Stars, which cannot therefore be leſs diſtant than* 3438 *Diameters of this great Orb, and conſequently* 68760000 *Diameters of the Earth: And if this Star be one of the neareſt, and that the Stars that are of one Degree leſſer in Magnitude (I mean not of the ſecond Magnitude, becauſe there may be many degrees between the firſt and ſecond) be as much farther; and another Sort yet ſmaller be three Times as far; and a Fourth four Times as far, and ſo onward, poſſibly to ſome hundred Degrees of Magnitude, ſuch as may be diſcovered by longer and longer Teleſcopes, that they may be a hundred Times as far; then certainly this material Expanſion, a Part of which we are, muſt be ſo great, that it will infinitely exceed our ſhallow Conceptions to imagine. Now, by what I laſt mentioned, it is evident, that Light extends itſelf to the utmoſt imaginable Parts, and by the Help of Teleſcopes, we collect the Rays, and make them ſenſible to the Eye, which are emitted from ſome of the moſt inconceivably remote Objects,* &c. — *Nor is it only the great Body of the Sun, or the vaſt Bodies of the fixed Stars, that are thus able to diſperſe the Light through the vaſt Expanſum of the Univerſe; but the ſmalleſt Spark of a lucid Body muſt do the very ſame Thing, even the ſmalleſt Globule ſtruck from a Steel by a Flint,* &c.

cal Inſtruments, and others in all Probability farther and farther, with better and better Inſtruments: And had we Inſtruments of Power equivalent to the Extent of Light, the luminous Bodies of the utmoſt Parts of the Univerſe, would, for the ſame Reaſon, be viſible too.

Now as Light is of greateſt Uſe to impower us to ſee Objects at all, ſo the Extenſion thereof is no leſs uſeful to enable us to ſee Objects afar off. By which Means we are afforded a Ken of thoſe many glorious Works of the infinite Creator, viſible in the Heavens, and can improve them to ſome of the nobleſt Sciences, and moſt excellent Uſes of our own Globe.

CHAP. V.

Of Gravity.

THE laſt Thing ſubſervient to our Globe, that I ſhall take Notice of, is *Gravity* (*a*); or that Tendency which Bodies have to the Centre of the Earth.

In

(*a*) That there is ſuch a Thing as *Gravity*, is manifeſt from its Effects here upon Earth; and that the heavenly Bodies attract or gravitate to one another, when placed at due Diſtances, is made highly probable by Sir *Iſaac Newton*. This attractive, or gravitating Power, I take to be congenial to Matter, and imprinted on all the Matter of the Univerſe by the Creator's *Fiat* at the Creation. What the *Cauſe* of it is, the *Newtonian Philoſophy* doth not pretend to determine for want of Phænomena, upon which Foundation it is that that Philoſophy is grounded, and not upon chimerical and uncertain Hypotheſes: But whatever the Cauſe is, that *Cauſe penetrates even to the Centres of the Sun and Planets, without any Diminution of its Virtue; and it acteth not according to the Superficies of Bodies (as Mechanical Cauſes do), but in Proportion to the Quantity of their ſolid Matter:* And laſtly, *it acteth all round it at immenſe Di-*

ſtances,

In my *Aſtro-Theology*, *Book* 6. *Chap*. 2. I have ſhewn of what abſolute Neceſſity, and what a noble

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ſtances, decreaſing in duplicate Proportion to thoſe Diſtances, as Sir *Iſaac Newton* ſaith, *Princip. pag*. ult. What uſeful Deductions, and what a rational Philoſophy, have been drawn from hence, may be ſeen in the ſame Book.

This Attraction, or Gravity, as its Force is in a certain Proportion, ſo makes the Deſcent of Bodies to be at a certain Rate. And was it not for the Reſiſtance of the Medium, all Bodies would deſcend to the Earth at the ſame Rate; the lighteſt Down as ſwiftly as the heavieſt Mineral: As is manifeſt in the *Air-Pump*, in which the lighteſt Feather, Duſt, *&c*. and a Piece of Lead, drop down ſeemingly in the ſame Time, from the Top to the Bottom of a tall exhauſted Receiver.

The Rate of the Deſcent of heavy Bodies, according to *Galilæo*, Mr. *Huygens*, and Dr. *Halley* (after them) is 16 Feet one Inch in one Second of Time; and in more Seconds, as the Squares of thoſe Times. But in ſome accurate Experiments made in St. *Paul*'s *Dome*, *June* 9, 1710, at the Height of 220 Feet, the Deſcent was ſcarcely 14 Feet in the firſt Second. The Experiments were made in the Preſence of ſome very conſiderable Members of the Royal Society, by Mr. *Hawkſbee*, their Operator, with Glaſs, hollow Balls, ſome empty, ſome filled with Quick-ſilver, the Barometer at 297, the Thermometer 60 Degrees above Freezing, the Weight of the Balls, their Diameters, and Time of the Deſcent is in this Table.

Balls filled with Quick-ſilver.			Empty Balls.			
Weight.	Diameter.	Time.	Weight.	Diameter.		Time.
Grains.	Tenth Inch.	Half Seconds.	Grains.	Inch.	Tenth	Half Seconds
908	8	8	510	5	1	17
993	8	8 leſs.	642	5	2	16
866	8	8	599	5	1	16
747	7 & half.	8 more,	515	5 nearly.		16 & half.
808	7 & half.	8	483	5 nearly.		17
784	7 & half.	8 more.	641	5	2	16

The Reaſon why the heavy Balls fell in half the Time of the hollow Ones, was the Reſiſtance of the Air: Which Reſiſtance is very ingeniouſly and accurately aſſigned by Dr. *Wallis*, in *Philoſ. Tranſ*. N° 186. And the Cauſe of the Reſiſtance of all Fluids, (as Sir *Iſaac Newton*, *Opt*. Q. 20.) is partly from the *Friction* of the Parts of the Fluid, partly from the *Inertia* thereof. The Reſiſtance a ſpherical Body meets with from Friction, is as the right Angle under the Diameter, and noble Contrivance this of Gravity is, for keeping the ſeveral Globes of the Univerſe from ſhattering to Pieces, as they evidently muſt do in a little Time, by their ſwift Rotation round their own Axes (*b*). The Terraqueous Globe particularly, which circumvolves at the rate of above 1000 Miles an Hour (*c*), would

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and the Velocity of the moving Body: And the Reſiſtance from the *Vis inertiæ*, is as the Square of that Product.

For a farther Account of the Properties and Proportions, &c. of Gravity in the Fall or Projection of Bodies, I ſhall refer to the larger Accounts of *Galilæus*, *Torricellius*, *Huygens*, Sir *Iſaac Newton*, &c. or to the ſhorter Accounts of Dr. *Halley*, in *Philoſoph. Tranſact.*. abridged by Mr. *Lowthorp*, vol. i. p. 561. or Dr. *Clarke*, in his Notes on *Rohault*, *Phyſ.* 2. *c.* 28. *ſect.* 13, 16. And for the Reſiſtance of Fluids, I refer to Dr. *Wallis*, before-cited, and the *Act. Erudit. Lipſ. May* 1693. where there is a Way to find the Force of Mediums upon Bodies of different Figures.

(*b*) That the Heavenly Bodies move round their own Axis, is, beyond all Doubt, manifeſt to our Eye, in ſome of them, from the Spots viſible on them. The Spots on the Sun (eaſily viſible with an ordinary Glaſs) do manifeſt him to revolve round his own Axis in about 25 Days and quarter. The Spots on *Jupiter* and *Mars* prove thoſe two Planets to revolve alſo from Eaſt to Weſt, as Dr. *Hook* diſcovered in 1664, and 1665. And *Venus* alſo (although near the ſtrong Rays of the Sun) hath, from ſome Spots, been diſcovered by Mr. *Caſſini*, in 1666, and 1667, to have a manifeſt Rotation. *Vide Lowthorp*'s *Abridg.* vol. i. p. 382, and 423, 425. And ſuch Uniformity hath the *Creator* obſerved in the Works of Nature, that what is obſervable in one, is generally to be found in all others of the ſame Kind. So that ſince it is manifeſt the Sun, and three of his Planets whirl round, it is very reaſonable to conclude all the reſt do ſo too; yea, every Globe of the Univerſe.

(*c*) The Earth's Circumference being 25031 Miles and half, (according to *Book* II. *Chap.* ii. *Note (a)* if we divide that into 24 Hours, we ſhall find the Motion of the Earth to be near 1043 Miles in an Hour. Which, by the bye, is a far more reaſonable and leſs rapid Rate than that of the Sun would be, if we ſuppoſe the Earth to ſtand ſtill, and the Sun to move round the Earth. For, according to the Proportions in Note (*e*) of the preceding Chapter, the Circumference of the *Magnus Orbis* is 540686225 *Engliſh* Miles, which divided by 24 Hours, gives 22528364 Miles in an Hour. But what is this would by the centrifugal Force of that Motion, be ſoon diſſipated and ſpirtled into the circumambient Space, was it not kept together by this noble Contrivance of the Creator, this natural inherent Power, namely, the Power of Attraction or Gravity.

And as by this Power our Globe is defended againſt Diſſipation, ſo all its Parts are kept in their proper Place and Order. All material Things do naturally gravitate thereto, and unite themſelves therewith, and ſo preſerve its Bulk intire (*d*). And the fleeting Waters, the moſt unruly of all its Parts, do by this Means keep their conſtant Æquipoiſe in the Globe (*e*), and remain in *that Place which*, the Pſalmiſt ſaith, *God hath founded for them*; *a Bound he had ſet, which they might not paſs*; *that they turn not again to cover the Earth*, Pſal. civ. 8, 9. So, that even in a natural Way, by vertue of this excellent Contrivance of the Creator, the Obſervation of the Pſalmiſt is perpetually fulfilled, *Pſal.* lxxxix. 9. *Thou ruleſt the raging of the Sea; when the Waves thereof ariſe, thou ſtilleſt them.*

To theſe, and an hundred other Uſes of Gravity that I might have named, I ſhall only juſt mention another Thing owing to it, and that is *Levity*, (*f*) that, whereby what we call light Bodies ſwim,

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to the Rapidity of the fixed Stars, if we ſuppoſe them, not the Earth, to move? Which is a good Argument for the Earth's Motion.

(*d*) *Nihil majus, quàm quòd ita ſtabilis eſt Mundus, atque ita cohæret ad permanendum, ut nihil nè excogitari quidem poſſit aptius. Omnes enim partes ejus undique medium locum capeſſentes, nituntur æqualiter: maximè autem corpora inter ſe juncta permanent, cùm quodam quaſi vinculo circumdata colligantur: quod facit ea natura, quæ per omnem mundum omnia Mente, & Ratione conficiens, funditur, & ad medium rapit, & convertit extrema.* Cic. de Nat. Deor. lib. ii. cap. 45.

(*e*) *Eâdem ratione Mare, cùm ſupra terram ſit, medium tamen terræ locum expetens, conglobatur undique æqualiter, neque redundat, unquam, neque effunditur.* Id. paulo poſt.

(*f*) That there is no ſuch Thing as *poſitive Levity*, but that Levity ſwim, a Thing no leſs uſeful to the World than its oppoſite, *Gravity*, is in many Reſpects, to divers Tribes of Animals, but particularly ſerviceable to the raiſing up of Vapours (*g*), and to their Conveyance about the World.

And now from this tranſient View of no other than the Out-works, than the bare Appendages of the Terraqueous Globe, we have ſo manifeſt a Sam-

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Levity is only a leſs Gravity, is abundantly manifeſted by the acute *Seign. Alph. Borelli de Mot. a Grav. pend.* cap. 4. See alſo the Annotations of the learned and ingenious Dr. *Clarke*, on *Rohaulti Phyſ.* p. 1. c. 16. note 3. Alſo the Experiments of the *Acad. del Cimento*, p. 118, &c. Dr. *Wallis*'s *Diſcourſe of Gravity and Gravitation, before the Royal Society*, Nov. 12, 1674, p. 28, &c.

(*g*) I have before, in *Note (a) Chap.* iii. ſhewn what *Vapours* are, and how they are raiſed. That which I ſhall here note, is their Quantity: Concerning which the before commended Dr. *Halley* hath given us ſome curious Experiments in our *Philoſoph. Tranſact.* which may be met with together in Mr. *Lowthorp*'s *Abridg.* vol. ii. p. 108, and 126. Mr. *Sedileau* alſo at *Paris* obſerved it for near three Years. By all their Obſervations it appears, that in the Winter Months the Evaporations are leaſt, and greateſt in Summer, and moſt of all in windy Weather. And by Monſ. *Sedileau*'s Obſervations it appears, that what is raiſed in Vapours exceeds that which falleth in Rain. In the ſeven laſt Months of the Year 1688, the Evaporations amounted to 22 Inches 5 Lines; but the Rain only 10 Inches 6 Lines one third: In 1689, the Evaporations were 32 Inches 10 Lines and a half; but the Rain 18 Inches 1 Line: In 1690, the Evaporations 30 Inches 11 Lines; the Rain 21 Inches one third of a Line. *Vide Mem. de Math. Phyſ. An.* 1692, p. 25.

If it be demanded, What becomes of the Overplus of Exhalations that deſcend not in Rain? I anſwer, They are partly tumbled down and ſpent by the Winds, and partly deſcend in Dews, which amount to a greater Quantity than is commonly imagined. Dr. *Halley* found the Deſcent of Vapours in Dews ſo prodigious at *St. Helena*, that he makes no doubt to attribute the Origin of Fountains thereto. And I myſelf have ſeen in a ſtill, cool Evening, large thick Clouds hanging, without any Motion, in the Air, which in two or three Hours time have been melted down by degrees, by the Cold of the Evening, ſo that not any the leaſt Remains of them have been left.

ple of the Wiſdom, Power, and Goodneſs of the infinite Creator, that it is eaſy to imagine the whole Fabrick is of a Piece, the Work of at leaſt a ſkilful Artiſt. A Man that ſhould meet with a Palace (*b*) beſet with pleaſant Gardens, adorned with ſtately Avenues, furniſhed with well-contrived Aqueducts, Caſcades, and all other Appendages conducing to Convenience or Pleaſure, would eaſily imagine, that proportionable Architecture and Magnificence were within: But we ſhould conclude the Man was out of his Wits that ſhould aſſert and plead, that all was the Work of Chance, or other than of ſome wiſe and ſkilful Hand. And ſo when we ſurvey the bare Out-works of this our Globe, when we ſee ſo vaſt a Body, accouter'd with ſo noble a Furniture of Air, Light, and Gravity; with every Thing, in ſhort, that is neceſſary to the Preſervation and Security of the Globe itſelf, or that conduceth to the Life, Health, and Happineſs, to the Propagation and Increaſe of all the prodigious Variety of Creatures the Globe is ſtocked with; when we ſee nothing wanting, nothing redundant or frivolous, nothing botching or ill-made, but that every Thing, even in the very Appendages alone, exactly anſwereth all its Ends and Occaſions: What elſe can be concluded, but that all was made with manifeſt Deſign, and that all the whole Structure is the Work of ſome intelligent Being; ſome Artiſt, of Power and Skill equivalent to ſuch a Work?

(*b*) See *Book* II. *Chap.* iii. *Note* (*c*).

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BOOK

BOOK II.

Of the Terraqueous Globe itſelf in General.

IN the foregoing Book having diſpatched the Out-works, let us take a Survey of the principal Fabrick, *viz.* the *Terraqueous Globe* itſelf; a moſt ſtupendous Work in every Particular of it, which doth no leſs Aggrandize its Maker (*a*), than every curious, complete Work doth its Workman. Let us caſt our Eyes here and there, let us ranſack all the Globe, let us with the greateſt Accuracy inſpect every Part thereof, ſearch out the inmoſt Secrets of any of the Creatures; let us examine them with all our Gauges,

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(*a*) *Licet — oculis quodammodo contemplari pulchritudinem earum rerum, quas Divinâ Providentiâ dicimus conſtitutas.... Ac principio Terra univerſa cernatur, locata in mediâ mundi ſede, ſolida, & globoſa — veſtita floribus, herbis, arboribus, frugibus. Quorum omnium incredibilis multitudo, inſatiabili varietate diſtinguitur. Adde huc Fontium gelidas perennitates, liquores perlucidos Amnium, Riparum veſtitus viridiſſimos. Speluncarum concavas altitudines, Saxorum aſperitates, impendentium Montium altitudines, immenſitateſque Camporum: Adde etiam reconditas Auri — venas — Quæ verò, & quàm variæ genera Beſtiarum? — Qui Volucrum lapſus, atque cantus? Qui Pecudum pactus? — Quid de Hominum genere dicam? Qui quaſi cultores terræ conſtituti, &c. —Quæ ſi, ut animis, ſic oculis videre poſſemus, nemo cunctam intuens terram, de Divina Ratione dubitaret.* Cic. de Nat. Deor. lib. ii. cap. 39.

meaſure them with our niceſt Rules, pry into them with our Microſcopes, and moſt exquiſite Inſtruments (*p*), ſtill we find them to bear Teſtimony to their infinite Workman; and that they exceed all human Skill ſo far, as that the moſt exquiſite Copies and Imitations of the beſt Artiſts, are no other than rude bungling Pieces to them. And ſo far are we from being able to eſpy any Defect or Fault in them, that the better we know them, the more we admire them; and the farther we ſee into them, the more exquiſite we find them to be.

And for a Demonſtration of this, I ſhall,

I. Take a general Proſpect of the Terraqueous Globe.

II. Survey its Particulars.

I. The Things which will fall under a general Proſpect of the Globe, will be its *Figure*, *Bulk*, *Motion*, *Place*, *Diſtribution* into Earth and Waters, and the great *Variety* of all Things upon it and in it.

(*p*) *I cannot here omit the Obſervations that have been made in theſe later Times, ſince we have had the Uſe and Improvement of the* Microſcope, *concerning the great Difference, which, by the Help of that, doth appear betwixt* Natural *and* Artificial *Things. Whatever is Natural, doth by that appear adorned with all imaginable Elegance and Beauty. — Whereas the moſt curious Works of Art, the ſharpeſt, fineſt Needle, doth appear as a blunt, rough Bar of Iron, coming from the Furnace, or the Forge. The moſt accurate Engravings or Emboſſments, ſeem ſuch rude, bungling, deformed Works, as if they had been done with a Mattock, or a Trowel. So vaſt a Difference is there betwixt the Skill of* Nature, *and the Rudeneſs and Imperfection of* Art. *Biſhop* Wilk. Nat. Rel. lib. i. ch. 6.

CHAP. I.

Of the Figure of the Terraqueous Globe.

THIS I ſuppoſe I may take for granted to be Spherical, or nearly ſo (*a*). And this muſt be allowed to be the moſt commodious, apt Figure for a World on many Accounts; as it is moſt capacious,

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(*a*) Although the Terraqueous Globe be of an Orbicular Figure, yet it is not ſtrictly ſo. 1. On account of its Hills and Vallies: But thoſe are inconſiderable to the Earth's Semidiameter; for they are but as Duſt upon a common Globe. But, 2. Our modern Aſtronomers aſſign a much greater Variation from a globulous Form, namely, that of a prolate Sphæroid, making the Polar about 34 Miles ſhorter than the Equatorial Diameter. The Cauſe of which they make to be the centrifugal Force of the diurnal Rotation of the Globe.

This Figure they imagine is in *Jupiter*, his Polar being to his Equatorial Diameter, as 39 three fifths to 40 three fifths. But whether it be ſo or no, I confeſs I could never perceive, although I have often viewed that Planet through very good, and long Glaſſes, particularly a tolerably good one of 72 Feet in my Hands: And although by reaſon of cloudy Weather, and (at preſent) *Jupiter's* Proximity to the Sun, I have not been of late able to take a Review of that Planet, yet *Saturn* (ſo far as his Ring would permit) and *Mars* appear perfectly round, through Mr. *Huygens's* long Glaſs of 126 Feet, which by Will he bequeathed, with its whole Apparatus, to our *Royal Society*, by whoſe Favour it is now in my Hands. And moreover, I believe it difficult, next to impoſſible, to meaſure the two Diameters to a 40th Part, by reaſon of the Smallneſs of *Jupiter's* apparent Diameter, and by reaſon he is moving all the Time of meaſuring him.

As to what is alledged for lengthening the Pendulums of Clocks, to make them keep the ſame time under the Equator, as they do in our Climes; I have ſhewn, from the like Variations in the Air-Pump, that this may ariſe from the Rarity of the Air there, more than here. *Vide Phil. Tranſact.* N° 294. But if the Degrees of a Meridian grow larger, the more we go towards the Line, (as Mr. *Caſſini* affirms they do, by an Sooth cious, as its Surface is equi-diſtant from the Centre, not only of the Globe, but at leaſt (nearly) of Gravity and Motion too, and as ſome have thought, of the central Heat and Waters. But theſe, and divers other Things I ſhall paſs over, and inſiſt only upon two or three other Benefits of this globous Figure of the Earth and Waters.

1. This Figure is the moſt commodious in regard of Heat, and I may add of Light alſo in ſome meaſure. For by this means, thoſe two great Benefits are uniformly and equally imparted to the World: They come harmoniouſly and gradually on, and as gradually go off again. So that the daily and yearly Returns of Light and Darkneſs, Cold and Heat, Moiſt and Dry, are Regular and Workman-like, (we may ſay) which they would not be, eſpecially the former, if the Maſs of Earth and Waters were (as ſome fancied (*b*) it) a large Plain; or as others, like

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Part in every Degree, in *Phil. Tranſ.* Nº 278.) then there is great Reaſon to conclude in behalf of this Sphæroidal Form.

The natural Cauſe of this Sphericity of our Globe, is (according to Sir *Iſaac Newton's* Principles) that *Attraction* which the infinite Creator hath ſtamped on all the Matter of the Univerſe, whereby all Bodies, and all the Parts of Bodies, mutually attract themſelves, and one another. By which Means, as all the Parts of Bodies tend naturally to their Center, ſo they all betake themſelves to a globous Figure, unleſs ſome other more prevalent Cauſe interpoſe. Thus Drops of Quickſilver put on a ſpherical Form, the Parts thereof ſtrongly attracting one another. So Drops of Water have the ſame Form, when falling in the Air; but are Hemiſpherical only when they lie on a hard Body, by reaſon their Gravity doth ſo far over-power their ſelf-attracting Power, as to take off one half of their Sphericity. This Figure is commonly attributed to the Preſſure of the circumambient Air: But that this cannot be the Cauſe, is manifeſt from the Air-Pump; the Caſe being the very ſame in an exhauſted Receiver as in the open Air, and not any the leaſt Alteration in the Figure that I could perceive, in all the Trials I have made.

(*b*) It would be frivolous as well as endleſs, to reckon up the various Opinions of the Ancients about the Figure of the Terra-like a large Hill in the midſt of the Ocean; or of a multangular Figure; or ſuch like.

2. This Figure is admirably adapted to the commodious and equal Diſtribution of the Waters in the Globe. For ſince, by the Laws of Gravity, the Waters will poſſeſs the loweſt Place; therefore, if the Maſs of the Earth was cubick, priſmatick, or any other angular Figure, it would follow, that one (too vaſt a Part) would be drowned, and another be too dry. But being thus orbicular, the Waters are equally and commodiouſly diſtributed here and there, according as the Divine Providence ſaw moſt fit; of which I ſhall take Notice by and by.

3. The orbicular Figure of our Globe, is far the moſt beneficial to the Winds and Motions of the Atmoſphere. It is not to be doubted, if the Earth was of ſome other, or indeed any other Figure, but that the Currents of Air would be much retarded, if not wholly ſtopped. We find by Experience, what Influence large and high Mountains, Bays, Capes, and Head-lands have upon the Winds; how they ſtop ſome, retard many, and divert and change (near the Shores) even the *general* and *conſtant Winds* (*c*), that blow round the Globe in the Tor-

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Terraqueous Globe; ſome of them may be ſeen in *Varen. Geogr.* lib. i. cap. 3. *init.* or *Johnſton*'s *Thaumat.* c. i. artic. 3. But among the Variety of Opinions, one of the principal was, That the viſible Horizon was the Bounds of the Earth, and the Ocean the Bounds of the Horizon; that the Heavens and Earth above this Ocean, was the whole viſible Univerſe; and that all beneath the Ocean was *Hades*, or the *inviſible World*. Hence, when the Sun ſet, he was ſaid *tingere ſe Oceano*; and when any went to *Hades*, they muſt firſt paſs the Ocean. Of this Opinion were not only the ancient Poets, and others among the Heathens, but ſome of the Chriſtian Fathers too, particularly *Lactantius*, St. *Auguſtine*, and others, who thought their Opinion was favoured by the Pſalmiſt, in *Pſal.* xxiv. 2. and cxxxvi. 6. See *Biſhop* Uſher's *Anſwer to a Jeſ. Chall.* p. 366, *&c.*

(*c*) *Neither do theſe conſtant* Trade-Winds *uſually blow near the Shore, but only on the Ocean, at leaſt* 30 *or* 40 *Leagues off at*

Sea,

gid Zone. And therefore, ſince this is the Effect of ſuch little Excreſcences, which have but little Proportion to our Globe, what would be the Conſequences of much vaſter Angles, which would equal a Quarter, Tenth, or but an Hundredth Part of the Globe's Radius? Certainly theſe muſt be ſuch a Barricade, as would greatly annoy, or rather abſolutely ſtop the Currents of the Atmoſphere, and thereby deprive the World of thoſe ſalutiferous Gales that I have ſaid keep it ſweet and clean.

Thus the Figure of our Globe doth manifeſt it to be a Work of Contrivance, inaſmuch as it is of the moſt commodious Figure; and all others would be liable to great and evident Inconveniencies.

◆

CHAP.

Sea, clear from any Land; eſpecially on the Weſt Coaſt, or Side, of any Continent: For indeed on the Eaſt Side, the Eaſterly Wind being the true Trade-Wind, blows almoſt home to the Shore, ſo near as to receive a Check from the Land-Wind. Dampier's Winds, chap. i.

And not only the *general Trade-Winds*, but alſo the *conſtant coaſting Trade-Winds*, are in like Manner affected by the Lands. Thus, for Inſtance, on the Coaſt of *Angola* and *Peru*. But this, ſaith the curious Captain *Dampier*, the Reader muſt take Notice of, *That the Trade-Winds that blow on any Coaſt, except the North Coaſt of* Africa, *whether they are conſtant, and blow all the Year, or whether they are ſhifting Winds, do never blow right in on the Shore, nor right along Shore, but go ſlanting, making an acute Angle of about 22 Degrees. Therefore, as the Land runs more Eaſt or Weſt, from North or South on the Coaſt; ſo the Winds do alter accordingly.* Ibid. chap. ii.

CHAP. II.

Of the Bulk of the Terraqueous Globe.

THE next Thing remarkable in the Terraqueous Globe, is the prodigious Bulk thereof (*a*). A Maſs of above 260 Thouſand Million of Miles ſolid Content. A Work too grand for any thing leſs than a God to make. To which in the next Place we may add,

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(*a*) It is not difficult to make a pretty near Computation of the Bulk of the Terraqueous Globe, from thoſe accurate Obſervations of a Degree made by Mr. *Norwood* in *England*, and Mr. *Picart* and Mr. *Caſſini* in *France*. Whoſe Meaſures do in a ſurprizing Manner agree. But Mr. *Caſſini*'s ſeeming to be the moſt accurate (as I have ſhewn in my *Aſtro Theology*, *Book* I. *Chap.* ii. *Note* (*a*), I have there made uſe of his Determinations. According to which the Diameter of the Earth being 7967,72 *Engliſh* Miles, its Ambit will be 25033 Miles and half; and (ſuppoſing it to be Spherical) its Surface will be 199444220 Miles; which being multiplied into one third of its Semidiameter, gives the ſolid Content, *viz.* 264856000000 Miles.

CHAP. III.

The Motions of the Terraqueous Globe.

THE Motions the Terraqueous Globe hath, are round its own Axis, and round its Fountain of Light and Heat, the Sun (*a*). That ſo vaſt a Body as the Earth and Waters ſhould be moved at

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(*a*) With the *Copernicans*, I take it for granted, that the Diurnal and Annual Revolutions are the Motions of the Terraqueous Globe, not of the Sun, &c. but for the Proof thereof I ſhall refer the Reader to the Preface of my *Aſtro-Theology*, and *Book* IV. *Chap.* iii.

all *(b)*, that it ſhould undergo two ſuch different Motions, as the Diurnal and Annual are, and that theſe Motions ſhould be ſo conſtantly and regularly *(c)* performed for near 6000 Years, without any the leaſt Alteration ever heard of, (except ſome Hours which we read of in *Joſh.* x. 12, 13. and in *Hezekiah*'s Time, which, if they cannot be accounted for ſome other Way, do greatly encreaſe the Wonder *(d)*; theſe Things, I ſay,) do manifeſtly argue

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(b) Every Thing that is moved, muſt of Neceſſity be moved by ſomething elſe; and that Thing is moved by ſomething that is moved either by another Thing, or not by another Thing. If it be moved by that which is moved by another, we muſt of Neceſſity come to ſome prime Mover, *that is not moved by another. For it is impoſſible, that what moveth, and is moved by another, ſhould proceed* in infinitum. Ariſtot. Phyſ. lib. viii. cap. 5.

Solum quod ſeipſum movet, quia nunquam deſeritur à ſe, nunquam ne moveri quidem deſinet: quinetiam cæteris quæ moventur, hic fons: hoc principium eſt movendi. Principii autem nulla eſt origo: nam ex principio oriuntur omnia; ipſum autem nullâ ex re aliâ naſcis poteſt: nec enim eſſet id principium, quod gigneretur aliunde. Cicer. Tuſc. Queſt. lib. i. cap. 23.

Cogitemus qui fieri poſſit, ut tanta magnitudo, ab aliquâ poſſit natura, tanto tempore circumferri? Ego igitur aſſero Deum cauſam eſſe, nec aliter poſſe fieri. Plato in Epinom.

(c) Among the Cauſes which *Cleanthes* is ſaid in *Tully* to aſſign for Men's Belief of a Deity, one of the chief is, *Æquabilitatem motûs, converſionem Cœli, Solis, Lunæ, Siderumque omnium diſtinctionem, varietatem, pulchritudinem, ordinem: quarum rerum aſpectus ipſe ſatis indicaret, non eſſe ea fortuita. Ut ſiquis in domum aliquam, aut in gymnaſium, aut in forum venerit; cùm videat omnium rerum rationem, modum, diſciplinam, non poſſe ea ſine cauſâ fieri judicare, ſed eſſe aliquem intelligat, qui præſit, & cui pareatur: multo magis in tantis motibus, tantiſque viciſſitudinibus, tam multarum rerum atque tantarum ordinibus, in quibus nihil unquam immenſa & infinita vetuſtas mentita ſit, ſtatuat neceſſe eſt ab aliquâ Mente tantos naturæ motus gubernari.* Cic. de Nat. Deor. lib. ii. cap. 5.

Homines cæperunt Deum agnoſcere, cùm viderent Stellus, tantam concinnitatem efficere; ac dies, noctesque, æſtate, & hyeme, ſuos ſervare ſtatos ortus, atque obitus. Plutarch. de Placit. lib. i. cap. 6.

(d) We need not be ſolicitous to elude the Hiſtory of theſe Miracles, as if they were only poetical Strains, as *Maimonides* and

argue ſome divine infinite Power to be concerned therein (e): But, eſpecially, if to all this we add the wonderful Convenience, yea, abſolute Neceſſity of theſe Circumvolutions to the Inhabitants, yea, all the Products of the Earth and Waters. For to one of theſe we owe the comfortable Changes of Day and Night; the one for Buſineſs, the other for Repoſe (f); the one for Man, and moſt other Animals to gather and provide Food, Habitation, and other Neceſſaries of Life; the other to reſt, refreſh, and recruit their Spirits (g), waſted with the Labours

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and ſome others fancy *Joſhua*'s Day to have been, *viz.* only an ordinary Summer's Day; but ſuch as had the Work of many Days done in it; and therefore by a poetical Stretch made, as if the Day had been lengthened by the Sun ſtanding ſtill. But in the Hiſtory they are ſeriouſly related, as real Matters of Fact, and with ſuch Circumſtances as manifeſt them to have been miraculous Works of the Almighty: And the Prophet *Habakkuk*, iii. 11. mentions that of *Joſhua*'s as ſuch. And therefore, taking them to be miraculous Perverſions of the Courſe of Nature, inſtead of being Objections, they are great Arguments of the Power of God: For in *Hezekiah*'s Caſe, to wheel the Earth itſelf backward, or, by ſome extraordinary Refractions, to bring the Sun's Shadow back 10 Degrees: Or, in *Joſhua*'s Caſe, to ſtop the diurnal Courſe of the Globe for ſome Hours, and then again give it the ſame Motion; to do, I ſay, theſe Things, required the ſame infinite Power, which at firſt gave the Terraqueous Globe its Motion.

(e) *Nam cum diſpoſiti quæſiſſem fœdera Mundi,*
Præſcriptoſque Maris fines, Annique meatus,
Et Lucis, Noctiſque vices: tunc omnia rebar
Conſilio firmata Dei, qui lege moveri
Sidera, qui fruges diverſo tempore naſci,
Qui variam Phœben alieno juſſerit igne
Compleri, Solemque ſuo; porrexerit undis
Littora; Tellurem medio libraverat axe.
Claudian in Rufin. lib. i. initio.

(f) *Diei noctiſque viciſſitudo conſervat animantes, tribuens aliud agendi tempus, aliud quieſcendi. Sic undique omnia ratione concluditur, Mente, Conſilioque divino omni in hoc mundo ad ſalutem omnium, conſervationemque admirabiliter adminiſtrari.* Cicer. de Nat. Deor. lib. ii. c. 53.

(g) The acute Dr. *Cheyne*, in his ingenious *Philoſ. Princ. of Natural* bours of the Day. To the other of thoſe Motions we owe the Seaſons of Summer and Winter, Spring and Autumn, together with the beneficial Inſtances and Effects which theſe have on the Bodies and State of Animals, Vegetables, and all other Things, both in the Torrid, Temperate, and Frigid Zones.

Natural Religion, among other Uſes of Day and Night, ſaith, the Night is moſt proper for Sleep; becauſe when the Sun is above the Horizon, Sleep is prejudicial, by Reaſon the Perſpirations are then too great. Alſo that Nutrition is moſtly, if not altogether, performed in Time of Reſt; the Blood having too quick a Motion in the Day; for which Reaſon, weak Perſons, Children, &c. are nouriſhed moſt, and recruit beſt, by Sleep.

CHAP. IV.

Of the Place and Situation of the Terraqueous Globe, in reſpect to the Heavenly Bodies.

ANother Thing very conſiderable in our Globe, is its Place and Situation at a due Diſtance from the Sun (*a*), its Fountain of Light and Heat; and from its neighbouring Planets of the ſolar Syſtem, and from the fix'd Stars. But theſe Things I have ſpoken more largely of in my *Survey of the Hea-*

(*a*) It is a manifeſt Sign of the Creator's Management and Care, in placing the Terraqueous Globe at that very Diſtance it is from the Sun, and contempering our own Bodies, and all other Things, ſo duly to that Diſtance. For was the Earth farther from the Sun, the World would be ſtarved and frozen with Cold: And was it nigher, we ſhould be burnt, at leaſt the moſt combuſtible Things would be ſo, and the World would be vexed with perpetual Conflagrations. For we ſee that a few of the Rays of the Sun, even no more than what fall within the Compaſs of half an Inch or an Inch in a Burning-Glaſs, will fire combuſtible Bodies, even in our own Climate.

vens (*b*), and therefore only barely mention them now: to inſiſt more largely upon,

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(*b*) *Aſtro-Theology*, Book VII. chap. vii.

CHAP. V.

The Diſtribution of the Earth and Waters.

THE Diſtribution of the Waters, and the dry Land, although it may ſeem rude and undeſigned to a careleſs View, and is by ſome tax'd as ſuch (*a*), yet is admirably well adjuſted to the Uſes and Conveniencies of our World. For

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(*a*) The moſt eminent Author I have met with, that finds fault with the Diſtribution of the Earth and Waters, and indeed with the whole preſent Structure of the Globe, is the learned and eloquent Theoriſt, Dr. *Burnet*, who frequently exclaims on this Point: *Tellus noſtra, ſi totam ſimul complectamur, non eſt ordinata & venuſta rerum compages —ſed moles aggeſta vario, incertoque citu partium, nullâ ordinis aut venuſtatis habitâ ratione.* Theor. Sacr. lib. i. cap. 7. *Ecquis autem à Deo hæc ita facta? &c.* ib. *Quo autem Herculeo labore opus eſſet ad excavandam terram in tantum hiatum? — Si immediatè à cauſâ primâ effectus fuiſſet hic alveus, aliquem ſaltem ordinem, menſuram, & proportionem notare voluiſſet in ipſius formâ, & partium diſpoſitione; — ſed confuſa omnia, &c.* ib. cap. 8. *Tellus noſtra cum exigua ſit; eſt etiam rudis: Et in illa exiguitate multa ſunt ſuperflua, multa inelegantia. Dimidiam terræ ſuperficiem inundat Oceanus; magnâ ex parte, ut mihi videtur, inutilis.* And then he goes on to ſhew how this Part of the Creation might be amended, *ibid. cap.* 10. All this to me is ſurprizing from an Author of great Ingenuity, who ſeems in his Book to have a juſt Opinion of, and due Veneration for God. But certainly ſuch Notions are very inconſiſtent with the Belief of God's creating, eſpecially his governing and ordering the World. But ſuppoſe the Terraqueous Globe was ſuch a rude, confuſed, inconvenient Maſs, as he pretends, yet it is well enough for a ſinful World. But beſides, what others have long ago abundantly

For in the firſt place, the Diſtribution is ſo well made, the Earth and Waters ſo handſomely, ſo Workman-like laid, every where all the World over, that there is a juſt Æquipoiſe of the whole Globe: The *Northern* balanceth the *Southern Ocean*, the *Atlantick* the *Pacifick Sea*. The *American dry Land* is a Counterpoiſe to the *European*, *Aſiatick*, and *African*.

In the next place, the Earth and the Waters are ſo admirably well placed about in the Globe, as to be helpful to one another, to miniſter to one another's Uſes. The great Oceans, and the leſſer Seas and Lakes, are ſo admirably well diſtributed throughout the Globe (*b*), as to afford ſufficient Vapours (*c*) for Clouds

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abundantly anſwered, the following Survey will, I hope, ſufficiently manifeſt it to be the Work of a wiſe and beneficent, as well as omnipotent Creator.

(*b*) Some have objected againſt the Diſtribution of the Earth and Waters, as if the Waters occupied too large a Part of the Globe, which they think would be of greater Uſe, if it was dry Land. But then they do not conſider that this would deprive the World of a due Quantity of Vapours and Rain. For if the Cavities which contain the Sea, and other Waters, were deeper, although the Waters were no leſs in Quantity, only their Surfaces narrower and leſſer, the Evaporation would be ſo much the leſs, inaſmuch as thoſe Evaporations are made from the Surfaces, and are conſequently, in Proportion to the Surface, not the Depth or Quantity of Water.

(*c*) I took Notice before, in *Book* I. *Chap*. iii. *Note* (*a*), That the Vapours conſtituting Clouds and Rain, are *Veſiculæ* of Water detached by Heat. The manner of which I conceive to be thus; Heat being of an agile Nature, or the lighteſt of all Bodies, eaſily breaks looſe from them; and if they are humid, in its Paſſage, carries along with it Particles, or little Caſes of Water; which being lighter than Air, are buoyed up thereby, and ſwim in it; until by knocking againſt one another, or being thickened by the Cold, (as in the Note before-cited) they are reduced into Clouds and Drops.

Having mentioned the Manner how Vapours are raiſed, and there being more Room here than in the Note before-cited, I ſhall, for the Illuſtration of Nature's Proceſs, take Notice of three Things obſervable to our Purpoſe, in Water over the Fire. I. That the Evaporations are proportional to the Heat aſcen-

Clouds and Rains, to temperate the Cold (*c*) of the Northern frozen Air, to cool and mitigate the Heats

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aſcending out of the Water. A ſmall Heat throws off but few Vapours, ſcarce viſible: A greater Heat, and aſcending in greater Quantities, carries off groſſer, larger, and more numerous *Veſiculæ*, which we call a *Steam:* and if the Heat breaks through the Water with ſuch a Fury, as to lacerate and lift up great Quantities or Bubbles of Water, too heavy for the Air to carry or buoy up, it cauſeth what we call *Boiling*. And the Particles of Water thus mounted up by the Heat, are viſible Sphærules of Water, if viewed with a Microſcope as they ſwim about in a Ray of the Sun let into a dark Room, with warm Water underneath: where ſome of the Vapours appear large, ſome ſmaller Sphærules, according (no Doubt) to the larger and leſſer Quantities of Heat blowing them up and carrying them off. 2. If theſe Vapours be intercepted in their Aſcent by any Context, eſpecially cold Body, as Glaſs, Marble, &c. they are thereby reduced into Drops and Maſſes of Water, like thoſe of Rain, &c. 3. Theſe Vapours, in their Aſcent from the Water, may be obſerved in cold froſty Weather, either to riſe but a little above the Water, and there to hang, or to glide on a little above its Surface: Or if the Weather be very cold, after a little Aſcent, they may be ſeen to fall back again into the Water; in their Aſcent and Deſcent deſcribing a Curve ſomewhat like that of an Arrow from a Bow. But in a warmer Air, and ſtill, the Vapours aſcend more nimbly and copiouſly, mounting up aloft till they are out of ſight. But if the Air be warm and windy too, the Vapours are ſooner carried out of Sight, and make Way for others. And accordingly I have often obſerved, that hot Liquors, if not ſet too thin, and not frequently ſtirred, cool ſlower in the greateſt Froſts, than in temperate Weather, eſpecially if windy. And it is manifeſt by good Experiments, that the Evaporations are leſs at thoſe Times than theſe; leſs by far in the Winter than the warmer Months.

(*c*) As our Northern Iſlands are obſerved to be more temperate than our Continents (of which we had a notable Inſtance in the great Froſt in 1708-9, which *Ireland* and *Scotland* felt leſs of than moſt Parts of *Europe* beſides; of which ſee *Book* IV. *Chap.* xii. *Note (c)*, ſo this Temperature is owing to the warm Vapours afforded chiefly by the Sea, which, by the preceding Note, muſt neceſſarily be warm, as they are Vapours, or Water inflated by Heat.

The Cauſe of this Heat I take to be partly that of the Sun, and partly Subterraneous. That it is not wholly that of the Sun, is manifeſt from Vapours being as, or more, copiouſly

Heats (*d*) of the Torrid Zone, and to refreſh the Earth with fertile Showers; yea, in ſome Meaſure to miniſter freſh Waters to the Fountains and Rivers. Nay, ſo abundant is this great Bleſſing, which the moſt indulgent Creator hath afforded us by Means of this Diſtribution of the Waters I am ſpeaking of, that there is more than a ſcanty, bare Proviſion, or mere Sufficiency; even a Plenty, a Surpluſage of this uſeful Creature of God, (the freſh Waters) afforded to the World; and they ſo well ordered, as not to drown the Nations of the Earth, nor to ſtagnate, ſtink, and poiſon, or annoy them; but to be gently carried through convenient Channels back again to their grand Fountain (*e*) the Sea; and many of them

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ouſly raiſed when the Sun-beams are weakeſt, as when ſtrongeſt, there being greater Rains and Winds at the one Time than the other. And that there is ſuch a Thing as *Subterraneous Heat*, (whether Central, or from the Meeting of Mineral Juices; or ſuch as is Congenial or Connatural to our Globe, I have not Time to enquire; but I ſay, that ſuch a Thing is,) is evident, not only from the Hot-Baths, many fiery Eruptions and Exploſions, &c. but alſo from the ordinary Warmth of Cellars and Places under Ground, which are not barely comparatively warm, but of ſufficient Heat to raiſe Vapours alſo: as is manifeſt from the ſmoking of perennial Fountains in froſty Weather, and Water drawn out of Pumps and open Wells at ſuch a Time. Yea, even Animals themſelves are ſenſible of it, as particularly *Moles*, who dig before a Thaw, and againſt ſome other Alterations of the Weather; excited, no doubt, thereunto by the ſame warm Vapours ariſing in the Earth, which animate them, as well as produce the ſucceeding Changes of the Weather.

(*d*) Beſides the *Trade-Winds*, which ſerve to mitigate the exceſſive Heats in the Torrid Zone; the Clouds are a good Screen againſt the ſcorching Sun-Beams, eſpecially when the Sun paſſeth their Zenith; at which Time is their Winter, or cooleſt Seaſon, by Reaſon they have then moſt Clouds and Rain. For which Service, that which *Varene* takes Notice of, is a great Providence of God, *viz. Pleraque loca Zonæ Torridæ vicinum habent mare, ut India, Inſulæ Indicæ, Lingua Africæ, Guinea, Braſilia, Peruvia, Mexicana, Hiſpania: Pauca loca Zonæ Torridæ ſunt Mediterranea.* Varenii Geogr. lib. ii. cap. 26. prop. 10. ſect 7.

(*e*) That Springs have their Origin from the Sea; and not from them through ſuch large Tracts of Land, and to ſuch prodigious Diſtances, that it is a great Wonder the Foun-

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from Rains and Vapours, among many other ſtrong Reaſons, I conclude from the Perennity of divers Springs, which always afford the ſame Quantity of Water. Of this Sort there are many to be found everywhere. But I ſhall, for an Inſtance, ſingle out one in the Pariſh of *Upminſter*, where I live, as being very proper for my Purpoſe, and one that I have had better Opportunities of making Remarks upon above twenty Years. This in the greateſt Drouths is little, if at all diminiſhed, that I could perceive by my Eye, although the Ponds all over the Country, and an adjoining Brook, have been dry for many Months together; as particularly in dry Summer Months of the Year 1705. And in the wetteſt Seaſons, ſuch as the Summer and other Months were, preceding the violent Storm in *November* 1703. (*Vide Phil. Tranſ.* N° 289.) I ſay, in ſuch wet Seaſons I have not obſerved any Increment of its Stream, excepting only for violent Rains falling therein, or running down from the higher Land into it; which diſcoloureth the Waters oftentimes, and makes an Increaſe of only a Day's or ſometimes but a few Hours Continuance. But now, if this Spring had its Origin from Rain and Vapours, there would be an Increaſe and Decreaſe of the one, as there ſhould happen to be of the other: As actually it is in ſuch temporary Springs as have undoubtedly their Source from Rain and Vapours.

But beſides this, another conſiderable Thing in this *Upminſter* Spring (and Thouſands of others) is, that it breaks out of ſo inconſiderable an Hillock, or Eminence of Ground, that can have no more Influence in the Condenſation of the Vapours, or ſtopping the Clouds, (which the Maintainers of this Hypotheſis ſuppoſe) than the lower Lands about it have. By ſome Critical Obſervations I made with a very nice portable Barometer, I found that my Houſe ſtands between 80 and 90 Feet higher than the Low-Water Mark in the River of *Thames*, neareſt me; and that Part of the River being ſcarce thirty Miles from the Sea, I gueſs, (and am more confirmed from ſome later Experiments I made nearer the Sea) that we cannot be much above 100 Feet above the Sea. The Spring I judge nearly level with, or but little higher than where my Houſe ſtands; and the Lands from whence it immediately iſſues, I gueſs about 15 or 20 Feet higher than the Spring; and the Lands above that, of no very remarkable Height. And indeed, by actual Meaſure, one of the higheſt Hills I have met with in *Eſſex*, is but 363 Feet high; (*Vide Phil. Tranſact.* N° 313, p. 16.) and I gueſs by ſome very late Experiments I made, neither that, nor any other Land in *Eſſex*, to be above 400 Feet above the Sea.

Fountains ſhould be high enough *(f)*, or the Seas low enough, ever to afford ſo long a Conveyance. Witneſs the *Danube (g)* and *Wolga* of *Europe*, the *Nile (h)* and the *Niger (i)* of *Africk*, the *Ganges (k)*

and

Now what is ſo inconſiderable a Riſe of Land to a perennial Condenſation of Vapours, *fit* to maintain even ſo inconſiderable a Fountain as what I have mentioned is? Or indeed the Highlands of the whole large County of *Eſſex*, to the maintaining of all its Fountains and Rivulets?

But I ſhall not farther proſecute this Argument, but refer to the late learned, curious, and induſtrious Dr. *Plot's Tentamen Phil. de Orig. Font.* in which he hath fully diſcuſſed this Matter.

As to the Manner how the Waters are raiſed up into the Mountains and higher Lands, an eaſy and natural Repreſentation may be made of it, by putting a little Heap of Sand, Aſhes, or a little Loaf of Bread, *&c.* in a Baſon of Water; where the Sand will repreſent the dry Land, or an Iſland, and the Baſon of Water the Sea about it. And as the Water in the Baſon riſeth to, or near the Top of the Heap in it, ſo doth the Waters of the Sea, Lakes, *&c.* riſe in the Hills. Which Caſe I take to be the ſame with the Aſcent of Liquids in Capillary Tubes, or between contiguous Planes, or in a Tube filled with Aſhes: Of which the induſtrious and complete Artificer in Air Pumps, Mr. *Hawkſbee*, hath given us ſome, not contemptible Experiments, in his *Phyſ. Mech. Exp. p.* 139.

Among the many Cauſes aſſigned for this Aſcent of Liquors, there are two that bid the faireſt for it, *viz. the Preſſure of the Atmoſphere*, and the *Newtonian Attraction.* That it is not the former, appears from the Experiments ſucceeding, as well, or better, in *Vacuo*, than in the open Air, the Aſcent being rather ſwifter in *Vacuo.* This then being not the Cauſe, I ſhall ſuppoſe the other is; but for the Proof thereof I ſhall refer to ſome of our late *Engliſh* Authors, eſpecially ſome very late Experiments made before our moſt famous *Royal Society*, which will be ſo well improved by ſome of that illuſtrious Body, as to go near to put the Matter out of doubt.

(f) See *Book* III. *Chap.* iv.

(g) The Danube, *in a ſober Account, performs a Courſe of above* 1500 *Miles (i. e.* in a ſtrait Line) *from its Riſe to its Fall.* Bohun's Geogr. Dict.

(h) Tractus ſc. *Longitudo* [Nili] *eſt milliarium circiter* 630 *Germ. ſive Ital.* 2520, *pro quibus ponere licet* 3000 *propter curvaturas.* Varen. Geogr. lib. i. cap. 16. p. 27.

(i) Varene reckons the Courſe of the *Niger*, at a middle Computation, 600 *German* Miles, that is 2400 *Italian.*

(k) That of the *Ganges* he computes at 300 *German* Miles.

But

and *Euphrates* of *Aſia*, and the *Amazons River* (*l*) and *Rio de la Plata* of *America*, and many others which might be named; ſome of which are ſaid to run above 5000 Miles, and ſome no leſs than 6000 from their Fountains to the Sea. And indeed ſuch prodigious Conveyances of the Waters make it manifeſt, that no accidental Currents and Alterations of the Waters themſelves, no Art or Power of Man, nothing leſs than the *Fiat* of the Almighty, could ever have made, or found, ſo long and commodious Declivities, and Channels for the Paſſage of the Waters.

But if we add the Curvatures to theſe Rivers, their Channels are of a prodigious Length.

(*l*) *Oriter, flumen (quod plerumque Amazonum, &c.) haud procul Quito in montibus — Cum per leucas Hiſpanicas* 1356. *curſum ab occidente in orientem continuârit, oſtio* 84 *leucas lato — in Oceanum præcipitatur.* Chr. D'Acugna Relatio de flumine Amaz. in Act. Erud. Aug. 1683.

CHAP. VI.

The great Variety and Quantity of all Things upon, and in the Terraqueous Globe, provided for the Uſes of the World.

THE laſt Remark I ſhall make about the Terraqueous Globe in general is, the great Variety of Kinds, or Tribes, as well as prodigious Number of Indiviuals of each various Tribe, there is of all Creatures (*a*). There are ſo many Beaſts, ſo many Birds,

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(*a*) *Non dat Deus beneficia? Unde ergò iſta quæ poſſides? — Unde hæc innumerabilia, oculos, aures & animum mulcentia? Unde illa luxuriam quoque inſtruens copia? Neque enim neceſſitatibus tantum-*

Birds, ſo many Inſects, ſo many Reptiles, ſo many Trees, ſo many Plants upon the Land; ſo many Fiſhes, Sea-plants, and other Creatures in the Waters; ſo many Minerals, Metals, and Foſſiles in the Subterraneous Regions; ſo many *Species* of theſe *Genera*, ſo many *Individuals* of thoſe *Species*, that there is nothing wanting to the Uſe of Man, or any other Creature of this lower World. If every Age doth change its Food, its way of Cloathing, its way of Building; if every Age (*b*) hath its Variety of Diſeaſes; nay, if Man, or any other Animal, was minded to change theſe Things every Day, ſtill the Creation would not be exhauſted, ſtill nothing would be wanting for Food, nothing for Phyſick, nothing for Building and Habitation, nothing for Cleanlineſs and Refreſhment, yea, even for Recreation and Pleaſure. But the Munificence of the Creator is ſuch, that there is abundantly enough to ſupply the Wants, the Conveniencies, yea, almoſt the Extravagancies of all the Creatures, in all Places, all Ages, and upon all Occaſions.

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tantummodò noſtris proviſum eſt: uſque in delicias amamur. Tot arbuſta, non uno modo frugifera, tot herbæ ſalutares, tot varietates ciborum, per totum annum digeſtæ, ut inerti quoque fortuita terræ alimenta præberent. Jam animalia omnis generis, alia in ſicco, &c. — ut omnis rerum naturæ pars tributum aliquod nobis conferret. Senec. de Benef. lib. iv. cap. 5. ubi plura vide.

Hic, ubi habitamus non intermittit ſuo tempore Cœlum niteſcere, arbores frondeſcere — tum multitudinem pecudum partim ad veſcendum, partim ad cultus agrorum, partim ad vehendum, partim ad corpora veſtienda; hominemque ipſum quaſi contemplatorem cœli ac deorum, ipſorumque cultorem. — Hæc igitur, & alia innumerabilia cùm cernimus, poſſumuſne dubitare, quin his præſit aliquis vel Effector, ſi hæc nata ſunt, ut Platoni videtur: vel ſi ſemper fuerint, ut Ariſtoteli placet, Moderator tanti operis & muneris? Cic. Tuſc. Queſt. lib. i. cap. 28, 29.

(*b*) *Sunt & gentium differentiæ non mediocres — quæ contemplatio aufert rurſus nos ad ipſorum animalium naturas, ingenitaſque iis vel certiores morborum omnium medicinas. Enim verò rerum omnium Parens, nullum animal ad hoc tantum ut paſceretur, aut alia ſatiaret naſci voluit: arteſque ſalutares iis inſeruerit.* Plin. Nat. Hiſt. lib. xxvii. cap. 13.

And this may ſerve to anſwer an Objection againſt the Excellency of, and Wiſdom ſhewed in, the Creation; namely, What need of ſo many Creatures *(c)*? Particularly of ſo many Inſects, ſo many Plants, and ſo many other Things? And eſpecially of ſome of them, that are ſo far from being uſeful, that they are very noxious; ſome by their Ferity, and others by their poiſonous Nature, *&c.*

To which I might anſwer, That in greater Variety, the greater Art is ſeen; that the fierce, poiſonous, and noxious Creatures ſerve as Rods and Scourges to chaſtiſe us *(d)*, as Means to excite our Wiſdom,

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(c) This was no very eaſy Queſtion to be anſwered by ſuch as held, That *all Things were made for Men*; as moſt of the Ancients did; as *Ariſtotle*, *Seneca*, *Cicero*, and *Pliny*, (to name only ſome of the Chief.) And *Cicero* cites it as the celebrated *Chryſippus*'s Opinion, *Præclarè enim Chryſippus, Cætera nata eſſe Hominum Cauſâ, & Deorum.* De fin. bon. & mal. lib. iii. And in his *De Nat. Deor. lib.* ii. *fin.* he ſeriouſly proves the World itſelf to have been made for the Gods and Man, and all Things in the World to have been made and contrived for the Benefit of Man, (*parata & inventa ad fructum Hominum*, are his Words.) So *Pliny*, in his Preface to his 7th Book, ſaith, Nature made all Things for Man; but then he makes a Doubt, Whether ſhe ſhewed herſelf a more indulgent Parent, or cruel Step-Mother, as in *Book* IV. *Chap.* xii. *Note (b)*. But ſince the Works of God have been more diſcovered, and the Limits of the Univerſe have been found to be of infinitely greater Extent than the Ancients ſuppoſed them; this narrow Opinion hath been exploded. And the Anſwer will be found eaſy to theſe Queſtions, Why ſo many uſeleſs Creatures? In the Heavens, Why ſo many fixed Stars, and the greateſt Part of them ſcarce viſible? Why ſuch Syſtems of Planets, as in *Jupiter*, *Saturn*, &c. (See my *Aſtro-Theology.*) In the Earth and Waters, Why ſo many Creatures of no Uſe to Man?

(d) Nec minùs clara exitii documenta ſunt etiam ex contemnendis animalibus. M. Varro author eſt à cuniculis ſuffoſſum in Hiſpaniâ oppidum, à talpis in Theſſaliâ: ab ranis civitatem in Galliâ pulſam, ab locuſtis in Africâ: ex Gyaro, Cycladum inſulâ, incolas à muribus fugatos: In Italiâ Amyclas à ſerpentibus delatas. Citra Cynamalgos Æthiopas latè deſerta regio eſt, à ſcorpionibus & ſolpugis gente ſublatâ: & à ſcolopendris abactos Trerienſes, author eſt Theophraſtus. Plin. Nat. Hiſt. lib. viii. cap. 29.

Wiſdom, Care, and Induſtry, with more to the ſame purpoſe. But theſe Things have been fully urged
by

To theſe Inſtances may be added the Plague they ſometimes ſuffer from a kind of Mice (they call *Leming*, *Leminger*, *Lemmus*, &c.) in *Norway*, which eat up every green Thing. They come in ſuch prodigious Numbers, that they fancy them to fall from the Clouds; but *Ol. Magnus* rather thinks they come from ſome of the Iſlands, *Hiſt. lib.* viii. *cap.* 2. If the Reader hath a mind to ſee a large Account of them, with a Diſpute about their Generation, a handſome Cut of them, with the Prayers and an Exorciſm againſt them uſed in the Church of *Rome*, I ſhall refer him (it being too tedious to recite in theſe Notes) to *Muſeum Wormian.* lib. iii. cap. 23.

Quare patimur multa mala à creaturâ quam fecit Deus niſi quia offendimus Deum? — De pœnâ tuâ peccatum tuum accuſa, non judicem. Nam propter Superbiam inſtituit Deus creaturam iſtam minimam & abjectiſſimam ut ipſa nos torqueret, ut cum ſuperbus fuerit homo, & ſe jactaverit adverſus Deum — cum ſe erexerit, Pulicibus ſubdatur. Quid eſt quòd te inflas humanâ ſuperbiâ? — Pulicibus reſiſte ut dormias. Cognoſce qui ſis. Nam propter ſuperbiam noſtram domandum — creata illa quæ moleſta ſunt: populum Pharaonis ſuperbum potuit Deus domare de Urſis, de, &c. Muſcas & Ranas illis immiſit, ut rebus viliſſimis ſuperbia domaretur. Omnia ergo per ipſum — facta ſunt; & ſine ipſo factum eſt nihil. Auguſt. Tract. 1. in S. Johan.

But although the infinitely wiſe Creator hath put it in the Power of ſuch vile Animals to chaſtiſe us, yet hath he ſhewed no leſs Wiſdom and Kindneſs in ordering many, if not moſt of them ſo, as that it ſhall be in the Power of Man, and other Creatures, to obviate or eſcape their Evils. For, beſides the noble Antidotes afforded by Minerals, Vegetables, &c. many, if not moſt of our *European* venomous Animals carry their Cure, as well as Poiſon, in their own Bodies. The Oil, and, I doubt not, the Body of *Scorpions* too, is a certain Remedy againſt its Stroke. A *Bee*, *Waſp*, or *Hornet*, cruſhed and rubbed, and bound upon the Place, I have always found to be a certain Cure for the Sting of thoſe Creatures. And I queſtion not, but the Fleſh, eſpecially the Head, of *Vipers*, would be found a Remedy for their Bites.

Our Viper-Catchers have a Remedy, in which they place ſo great Confidence, as to be no more afraid of the Bite [of a Viper] *than of a common Puncture, immediately curing themſelves by the Application of their Specifick. This, though they keep a great Secret, I have, upon ſtrict Enquiry, found to be no other than* Axungia Viperina, *preſently rubbed into the Wound.* This Remedy the learned by others; and it is ſufficient to ſay, that this great Variety is a moſt wiſe Proviſion for all the Uſes of the World in all Ages, and all Places. Some for Food, ſome for Phyſic (*e*), ſome for Habitation, ſome for Utenſils, ſome for Tools and Inſtruments of Work, and ſome for Recreation and Pleaſure, either to Man, or to ſome of the inferior Creatures themſelves; even for which inferior Creatures, the liberal Creator hath provided all Things neceſſary, or any ways conducing to their happy, comfortable living in this World, as well as for Man.

And it is manifeſt, that all the Creatures of God, Beaſts, Birds, Inſects, Plants, and every other *Genus*, have, or may have, their ſeveral Uſes even among Men. For although in one Place many Things may lie neglected, and out of Uſe, yet in other Places they may be of great Uſe. So what hath ſeemed uſeleſs

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ed Doctor tried himſelf with good Succeſs in a young Dog that was bitten in the Noſe. *Vide Mead of Poiſons*, p. 29.

And as to the Means to eſcape the Miſchief of ſuch noxious Animals, beſides what may be effected by the Care, Induſtry, and Sagacity of Man; ſome of them are ſo contrived and made, as to give Warning or Time to Creatures in Danger from them. Thus, for Inſtance, the *Rattle Snake*, the moſt poiſonous of any Serpent, who darts his poiſonous Vapours to ſome Diſtance, and in all Probability was the *Baſiliſk* of the Ancients, ſaid to kill with its Eyes: This involuntarily gives Warning by the Rattle in its Tail. So the *Shark*, the moſt rapacious Animal of the Waters, is forced to turn himſelf on his Back, (and thereby gives an Opportunity of Eſcape) before he can catch his Prey.

(*e*) *Hæc ſola Naturæ placuerat eſſe remedia parata vulgo, inventu facilia, ac ſine impendio, ex quibus vivimus. Poſteà fraudes hominum & ingeniorum capturæ officinas invenire iſtas, in quibus ſua cuique homini vænalis promittitur vitâ. Statim compoſitiones & miſturæ inexplicabiles decantantur. Arabia atque India in medio æſtimantur, ulcerique parvo medicina à Rubro mari imputatur, cùm remedia vera quotidie pauperrimus quiſque cænet.* Plin. lib. xxiv. cap. 21.

Non ſponte ſuâ ex tellure germinant Herbæ, quæ contra quoſcunque morbos accommodæ ſunt; ſed eæ voluntate Opificis, ad noſtram utilitatem productæ ſunt. Baſil. Aſcet. Tom. ii.

Conſult here *Book* X. *Note* (*z*), (*aa*), (*bb*).

in one Age, hath been received in another; as all the new Diſcoveries in Phyſick, and all the Alterations in Diet do ſufficiently witneſs. Many Things alſo there are which in one Form may be pernicious to Man; but in another of great Uſe. There are many Plants (*f*), many Animals, many Minerals, which in

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(*f*) Among poiſonous Vegetables, none more famous of Old than *Hemlock*, accounted at this Day alſo very dangerous to Man, of which there are ſome diſmal Examples in our *Philoſ. Tranſ. Wepfer*, &c. But yet this Plant is Food for *Goats*, and its Seeds to *Buſtards*; and, as *Galen* ſaith, to *Starlings* alſo. Neither is this, ſo pernicious a Plant, only Food, but alſo Phyſick to ſome Animals. An Horſe troubled with the *Farcy*, and could not be cured with the moſt famous Remedies, cured himſelf of it in a ſhort Time, by eating *Hemlock*, of which he eat greedily. *Vide Phil. Tranſ.* N° 231. *And a Woman which was cured of the Plague, but wanted Sleep, did with very good Effect eat* Hemlock *for ſome Time; till falling ill again of a Fever, and having left off the Uſe of this Remedy, he* [Nic. Fontanus] *endeavoured to procure her Reſt by repeated Doſes of* Opium, *which had no Operation, till the Help of* Cicuta *was again called in with deſired Succeſs.* Mead of Poiſons, p. 144.

And not only *Hemlock*, but many other, if not moſt Plants accounted poiſonous, may have their great Uſe in Medicine: Of which take the Opinion of an able Judge, my ingenious and learned Friend, Dr. *Tancred Robinſon*, in a Letter I have of his to the late great Mr. *Ray*, of *Nov.* 7, 1704, viz. *According to my Promiſe, I here ſend you a few Obſervations concerning ſome Plants ſeldom uſed in Medicine, being eſteemed poiſonous, which, if truly corrected, or exactly doſed, may perhaps prove the moſt powerful and effectual Medicines yet known.* Having then given an Account of ſome of their Correctives, he gives theſe following Examples, *viz.* 1. *The Hellebores, incorporated with a Sapo, or Alkaly-Salts alone, are ſucceſsful Remedies in Epilepſies, Vertigoes, Palſies, Lethargies, and Manias. Doſ. a* ℈j *to* ʒß. 2. *The Radic. Aſſari, Cicutæ, and the Napellus, in Agues and periodical Pains, Doſ.* ℈j *to* ʒß. 3. *The Hyoſcyamus in Hæmorrhages, violent Heats and Perturbation of the Blood, and alſo in all great Inflammations, Doſ.* ℈j *to* ʒß. 4. *The Semen Stramoniæ is a very good Anodyne, uſeful in Vigilias, Rheumatiſms, Hyſterick Caſes, in all the Orgaſms of the Blood or Spirits, and wherever there is an Indication for a Paregorick, Doſ* ʒj. *to* ʒß. 5. *Elaterium thus corrected, may be given from gr.* x. *to* xv. *in Hydropical Caſes, without any ſenſible Evacuation or Diſturbance. So may the Soldanella and Gratiola in greater Doſes.* 6. *Opium corrected* in one Form deſtroy, in another heal. The *Caſſada Plant* unprepared poiſoneth, but prepared, is the very Bread of the *Weſt-Indies (g). Vipers* and *Scorpions*, and many Minerals, as deſtructive as they are to Man, yet afford him ſome of his beſt Medicines.

Or if there be many Things of little immediate Uſe to Man, in this, or any other Age; yet to other Creatures they may afford Food or Phyſick, or be of ſome neceſſary Uſe. How many Trees and Plants, nay, even the very Carcaſes of Animals, yea, the very Duſt of the Earth *(h)*, and the moſt refuſe, contemptible Things to be met with; I ſay, how many ſuch Things are either Food, or probably Medicine to many Creatures; afford them Retreat, are Places of Habitation, or Matrixes for their Generation, as ſhall be ſhewed in proper Place? The prodigious Swarms of inſects in the Air, and in the Waters, (many of which may be perhaps at preſent of no great Uſe to Man) yet are Food to Birds, Fiſhes, Reptiles, Inſects themſelves, and other Creatures *(i)*, for whoſe happy and comfortable Subſiſtence, I have ſaid the bountiful Creator hath liberally provided, as well as for that of Man.

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corrected as afore-mentioned, loſes its Narcotic Faculty, and may be given very ſafely in great Doſes, and proves more than uſually prevalent in Convulſive Caſes, Fluxes, Catarrhs, and all painful Paroxyſms, &c,

(g) It is of the moſt general Uſe of any Proviſion all over the Weſt Indies, *eſpecially in the hotter Parts, and is uſed to victual Ships.* Dr. *Sloan's* Nat. Hiſt. of *Jamaica*, vol. I. chap. v. ſect. 12.

(h) I have ſhewn in the *Philoſ. Tranſact.* that the *Pediculus fatidicus, Mortiſaga, Pulſatorius,* or *Death-Watch*, there deſcribed, feedeth upon Duſt; but that this Duſt they eat, is powdered Bread, Fruits, or ſuch like Duſt, not powdered Earth, as is manifeſt from their great Diligence and Curioſity in hunting among the Duſt. See more in *Philoſoph. Tranſact.* N° 291.

(i) See *Book* IV. *Chap.* xi.

BOOK III.

Of the Terraqueous Globe in Particular, more eſpecially the Earth.

HAVING thus taken a General Proſpect of our Terraqueous Globe, I ſhall in this Book come to its Particulars. But here we have ſuch an immenſe Variety preſenting itſelf to our Senſes, and ſuch amazing Strokes of Power and Wiſdom, that it is impoſſible not to be at a Stand, and very difficult to know where to begin, how to proceed, or where to end. But we muſt however attempt.

And for the more clear and regular Proceeding on this copious Subject, I ſhall diſtribute the Globe into its own grand conſtituent Parts.

I. The *Earth* and its Appurtenances.

II. The *Waters* and Theirs.

The firſt of theſe only, is what at preſent I ſhall be able to take into this Survey.

And in Surveying the *Earth*, I intend,

1. To conſider its conſtituent Parts, or Things peculiar to itſelf.

2. The Inhabitants thereof, or the ſeveral Kinds of Creatures that have their Habitation, Growth, or Subſiſtence thereon.

1. As to the Earth itſelf, the moſt remarkable Things that preſent themſelves to our View, are,

1. Its various Moulds and Soils.
2. Its ſeveral Strata, or Beds.
3. Its Subterraneous Paſſages, Grottos, and Caverns.
4. Its Mountains and Vallies.

CHAP. I.

Of the Soils and Moulds in the Earth.

THE various Soils and Moulds are an admirable and manifeſt Contrivance of the All-wiſe Creator, in making this Proviſion for the various Vegetables *(a)*, and divers other Uſes of the Creatures. For, as ſome Trees, ſome Plants, ſome Grains dwindle and die in a diſagreeable Soil, but thrive and flouriſh in others; ſo the All-wiſe Creator hath amply provided for every Kind a proper Bed.

(a) It is not to be doubted, that although Vegetables delight in peculiar Soils, yet they owe not their Life and Growth to the Earth itſelf, but to ſome agreeable Juice or Salts, *&c.* reſiding in the Earth. Of this the great Mr. *Boyle* hath given us ſome good Experiments. He ordered his Gardener to dig up, and dry in an Oven, ſome Earth fit for the Purpoſe, to weigh it, and to ſet therein ſome *Squaſh Seeds*, (a Kind of *Indian* Pompion.) The Seeds when ſown were watered with Rain or Spring-water only. But although a Plant was produced in one Experiment of near 3lb. and in another of above 14lb. yet the Earth when dried, and weighed again, was ſcarce diminiſhed at all in its Weight.

Another Experiment he alledges is of *Helmont's*, who dried 200lb. of Earth, and therein planted a Willow, weighing 5lb. which he watered with Rain, or diſtilled Water: And to ſecure it from any other Earth getting in, he covered it with a perforated Tin-Cover. After five Years, weighing the Tree with all the Leaves it had borne in that Time, he found it to weigh 169lb. 3 Ounces, but the Earth to be diminiſhed only about two Ounces in its Weight. *Vide Boyle's Scept. Chym. Part* ii. *p.* 114.

If ſome delight in a warm, ſome in a cold Soil; ſome in a lax or ſandy, ſome a heavy or clayie Soil; ſome in a Mixture of both, ſome in this, and that, and the other Mould, ſome in moiſt, ſome in dry Places *(b)*; ſtill we find Proviſion enough for all theſe Purpoſes: Every Country abounding with its proper Trees and Plants *(c)*, and every Vegetable flouriſhing and gay, ſomewhere or other about the Globe, and abundantly anſwering the Almighty Command of the Creator, when the Earth and Waters were ordered to their peculiar Place, *Gen.* i. 11. *And God ſaid, Let the Earth bring forth Graſs, the Herb yielding Seed, and the Tree yielding Fruit after his Kind.* All which we actually ſee is ſo.

To this Convenience which the various Soils that coat the Earth are of to the Vegetables, we may add their great Uſe and Benefit to divers Animals, to many Kinds of Quadrupeds, Fowls, Inſects, and Reptiles, who make in the Earth their Places of Repoſe and Reſt; their Retreat in Winter, their Security from their Enemies, and their Neſts to repoſe their Young; ſome delighting in a lax and pervious Mould, admitting them an eaſy Paſſage; and others delighting in a firmer and more ſolid Earth,

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(b) Τοὺς δὲ τόπους ζητεῖ τοὺς οἰκείους, οὐ μόνον τὰ περιττὰ — Τῶν δένδρων, &c. Τὰ μὲν γὰρ φιλεῖ ξηροὺς, τὰ δὲ ἐνύδρους, τὰ δὲ χειμερινοὺς, τὰ δὲ προσήλους, τὰ δὲ παλισκίους, καὶ ὅλως, τὰ μὲν ὀρεινοὺς τὰ δὲ ἑλώδεις. — Ζητεῖ γὰρ τὰ πρόσφορα κατὰ τὴν κρᾶσιν, ἔτι δὲ ἀσθενῆ, καὶ ἰσχυρὰ, καὶ βαθύῤῥιζα, καὶ ἐπιπολαιόῤῥιζα, καὶ εἴτις ἄλλη διαφορὰ, κατὰ τὰ μέρη — Πάντα γὰρ ταῦτα, ἔτι δὲ τὰ ὅμοια ζητεῖ τὸ ὅμοιον, καὶ τὰ ἀνόμοια μὴ τὸν αὐτὸν, ὅταν ᾖ τις παραλλαγὴ τῆς φύσεως. *Theophraſt. de Cauſ. Plant. lib.* ii. *cap.* 9.

(c) *Nec verò Terræ ferre omnes omnia poſſunt.*
Fluminibus, Salices, craſſiſque paludibus Alni
Naſcuntur; ſteriles ſaxoſis montibus Orni:
Littora Myrtetis lætiſſima: denique apertos
Bacchus amat colles: Aquilonem & frigora Taxi.
Aſpice & extremis domitum cultoribus orbem,
Eoaſque domos Arabum, pictoſque Gelonos:
Diviſæ arboribus patriæ, &c. Vir. Georg. I. 2.

that will better ſecure them againſt Injuries from without.

CHAP. II.

Of the various Strata, or Beds, obſervable in the Earth.

THE various *Strata*, or *Beds*, although but little different from the laſt, yet will deſerve a diſtinct Conſideration.

By the *Strata*, or *Beds*, I mean thoſe Layers of Minerals *(a)*, Metals *(b)*, Earth and Stone *(c)*, lying

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(a) Although Minerals, Metals, and Stones, lie in Beds, and have done ſo ever ſince *Noah*'s Flood, if not from the Creation; yet it is greatly probable that they have Power of *growing* in their reſpective Beds: That as the Beds are robbed and emptied by Miners, ſo after a while they recruit again. Thus *Vitriol*, Mr. *Boyle* thinks, will grow by the Help of the Air. So *Alum* doth the ſame. *We are aſſured* (he ſaith) *by the experienced* Agricola, *That the Earth, or Ore of* Alum, *being robbed of its Salt, will in Tract of Time recover it, being expoſed to the Air.* Boyle's Suſpic. about ſome Hid. Qual. in the Air, p. 18.

(b) As to the Growth of *Metals*, there is great Reaſon to ſuſpect that alſo, from what Mr. *Boyle* hath alledged in his *Obſervations about the Growth of Metals:* And in his *Scept. Chym. Part* vi. *p.* 362. Compare alſo *Hakewil*'s *Apol. p.* 164.

And particularly, as to the Growth of *Iron*, to the Inſtances he gives from *Pliny*, *Fallopius*, *Cæſalpinus*, and others, we may add, what is well known in the Foreſt of *Dean* in *Glouceſterſhire*; That the beſt Iron, and moſt in Quantity, that is found there, is in the old Cinders, which they melt over again. This the Author of the *Additions to Glouceſterſhire, in Camden's Brit.* of the laſt Edition, p. 245. attributes to the Remiſſneſs of the former Melters in not exhauſting the Ore: But, in all Probability, it is rather to be attributed to the new Impregnations of the old Ore, or Cinders, from the Air or from ſome ſeminal Principle, or plaſtick Quality in the Ore itſelf.

(c) As for the Growth of *Stone*, Mr. *Boyle* gives two Inſtances. One is that famous Place in *France*, called *Les Caves Goutieres: Where the Water falling from the Upper Parts of the Cave*

ing under that upper *Stratum*, or Tegument of the Earth laſt ſpoken of, all of a prodigious Uſe to Mankind: Some being of great Uſe for Building; ſome ſerving for Ornament; ſome furniſhing us with commodious Machines, and Tools to prepare our Food, and for Veſſels and Utenſils, and for Multitudes of other Uſes; ſome ſerving for Firing to dreſs our Food, and to guard us againſt the Inſults of Cold and Weather; ſome being of great Uſe in Phyſick, in Exchange and Commerce, in manuring and fertilizing our Lands, in dying and colouring, and ten thouſand other Conveniences, too many to be particularly ſpoken of: Only there is one grand Uſe of one of theſe Strata, or

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Cave to the Ground, doth preſently there condenſe into little Stones, of ſuch Figure as the Drops, falling either ſeverally, or upon one another, and coagulating preſently into Stones, chance to exhibit. Nid. Scept. Chym. p. 360.

Such like Caves as theſe I have myſelf met with in *England*; particularly on the very Top of *Bredon-Hill*, in *Worceſterſhire*, near the *Precipice*, facing *Perſhore*, in or near the old Fortreſs, called *Bembſbury-Camp*; I ſaw ſome Years ago ſuch a Cave, which (if I miſ-remember not) was lined with thoſe *Stalactical Stones* on the Top and Sides. On the Top they hung like Icicles great and ſmall, and many lay on the Ground. They ſeemed manifeſtly to be made by an Exſudation, or Extillation of ſome petrifying Juices out of the rocky Earth there. On the Spot, I thought it might be from the Rains ſoaking through, and carrying with it Impregnations from the Stone, the Hill being there all rocky. Hard by the Cave is one or more vaſt Stones, which (if I miſtake not) are incruſtated with this Sparry, Stalactical Subſtance, if not wholly made of it. But it is ſo many Years ago ſince I was at the Place, and not being able to find my Notes about it, I cannot ſay whether the whole Stone is (in all Probability) Spar (as I think it is,) or whether I found it only caſed over with it, notwithſtanding I was very nice in examining it then, and have now ſome of the Fragments by me, conſiſting, among other ſhining Parts, of ſome tranſparent angular Ones.

The other Inſtance of Mr. *Boyle*, is from *Linſchoten*, who ſaith, that in the *Eaſt Indies*, when they have cleared the Diamond Mines of all the Diamonds, *In a few Years Time they find in the ſame Place new Diamonds produced.* Boyle ibid.

Beds, that cannot eaſily be omitted, and that is, thoſe ſubterraneous Strata of Sand, Gravel, and laxer Earth that admit of, and facilitate the Paſſage of the ſweet Waters *(d)*, and may probably be the Colanders whereby they are ſweetened, and then at the ſame Time alſo convey'd to all Parts of the Habitable World, not only through the Temperate and Torrid Zones, but even the fartheſt Regions of the Frozen Poles.

That theſe Strata are the *principal Paſſages* of the ſweet Fountain-Waters, is, I think, not to be doubted, conſidering that in them the Waters are well known to paſs, and in them the Springs are found by thoſe that ſeek for them: I ſay, the principal

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(d) It is not only agreeable to Reaſon, but I am told by Perſons converſant in digging of Wells throughout this County of *Eſſex*, where I live, that the ſureſt Beds in which they find Water, are *Gravel*, and a coarſe dark-coloured *Sand*; which Beds ſeldom fail to yield Plenty of ſweet Water: but for *Clay*, they never find Water therein, if it be a ſtrong, ſtiff *Clay*; but if it be lax and ſandy, ſometimes Springs are found in it; yet ſo weak, that they will ſcarcely ſerve the Uſes of the ſmalleſt Family. And ſometimes they meet with thoſe Beds lying next, under a looſe, black Mould, (which, by their Deſcription, I judged to be a Sort of oazy, or to have the Reſemblance of an ancient, ruſhy Ground,) and in that Caſe the Water is always naught, and ſtinks. And laſtly, Another Sort of Bed they find in *Eſſex*, in the Claie-Lands, particularly that Part called the *Rodings*, which yields Plenty of ſweet Water, and that is a Bed of white Earth, as though made of Chalk and white Sand. This they find after they have dug through forty or more Feet of Clay; and it is ſo tender and moiſt, that it will not lie upon the Spade, but they are forced to throw it into their Buckets with their Hands, or with Bowls; but when it comes up into the Air, it ſoon becomes an hard white Stone.

Thus much for the Variety of Beds wherein the Waters are found. That it is in theſe Beds only, or chiefly, the Springs run, is farther manifeſt from the forcible Eruption of the Waters ſometimes out of thoſe watery Beds. Of which ſee *Ch.* iv. *Note (d)*. This Eruption ſhews that the Waters come from ſome Eminence or other, lying at a Diſtance, and being cloſely pent up within the *watery Stratum*, by the Clayie Strata, the Waters with Force mount up, when the Strata above are opened.

Paſſages, becauſe there are other ſubterraneous Guts and Channels, Fiſſures and Paſſages, thro' which many Times the Waters make their Way.

Now that which in a particular Manner doth ſeem to me to manifeſt a ſpecial Providence of God in the repoſiting theſe watery Beds is, that they ſhould be diſperſed all the World over, into all Countries, and almoſt all Tracts of Land: that they ſhould ſo entirely, or for the moſt Part, conſiſt of lax, incohering Earth, and be ſo ſeldom blended with other impervious Moulds, or if they are ſo, it is commonly but accidentally; and that they are interpoſed between the other impervious Beds, and ſo are as a Prop and Pillar to guard them off, and to prevent their ſinking in and ſhutting up the Paſſages of the Waters.

The Time when thoſe Strata were laid, was doubtleſs at the Creation, when *God ſaid* (Gen. i. 9.) *Let the Waters under the Heaven be gathered together unto one Place, and let the dry Land appear*; or elſe at the Deluge, if, with ſome ſagacious Naturaliſts, we ſuppoſe the Globe of Earth to have been diſſolved by the Flood (*e*). At that Time (whatever it was) when the Terraqueous Globe was in a Chaotick State, and the earthy Particles ſubſided, then thoſe ſeveral Beds were, in all Probability, repoſited in the Earth, in that commodious Order in which they now are found; and that, as is aſſerted, according to the Laws (*f*) of Gravity.

(*e*) *Vide* Dr. *Woodward*'s Eſſay, Part 2. *Steno*'s Prodr. &c.

(*f*) *Id. ibid.* p. 28, and 74. But Dr. *Leigh*, in his *Natural Hiſtory of Lancaſhire*, ſpeaking of the Coal-Pits, denies the Strata to lie according to the Laws of Gravitation, ſaying, the Strata are a Bed of *Marle*, afterwards *Free-Stone*, next *Iron-Stone*, then *Coal*, or *Kennel Mine*, then ſome other Strata, and again *Coal*, &c.

But upon a ſtricter Enquiry into the Matter, finding I had Reaſon to ſuſpect that few, if any, actually had tried the Experiment, I was minded to bring the Thing to the Teſt of Experiment myſelf; and having an Opportunity, on *April* 11, 1712. I cauſed

I cauſed divers Places to be bored, laying the ſeveral *Strata* by themſelves; which afterwards I weighed with all Strictneſs, firſt in Air, then in Water, taking Care that no Air-bubbles, *&c.* might obſtruct the Accuracy of the Experiment. The Reſult was, that, in my Yard, the Strata were gradually ſpecifically heavier and heavier, the lower and lower they went; and the upper, which was Clay, was conſiderably ſpecifically lighter than the lower *Stratum*; which was firſt a looſe Sand, then a Gravel. In which *Stratum* principally the Springs run that ſupply my Well.

But in my Fields, where three Places were bored, (to no great Depth) I found below the upper (ſuperficial *Stratum)* a deep Bed of Sand only, which was of different Colours and Conſiſtence, which I weighed as before, together with the Virgin-Mould; but they were all of the ſame, or nearly the ſame ſpecifick Gravity, both out of the ſame Hole, and out of different Holes, although the Sand was at laſt ſo gravelly, that it hindered our boring any deeper.

Upon this, fearing leſt ſome Error might be in the former Experiments, I tried them over again; and that with the ſame Succeſs.

After this I made ſome Experiments in ſome deep Chalk-Pits, with the Flints, Chalk, *&c.* above and below; but the Succeſs was not ſo uniform as before.

Acquainting our juſtly Renowned *Royal Society* with theſe Experiments, they ordered their Operator to experiment the *Strata* of a Coal-Pit; the Succeſs whereof may be ſeen in the *Philoſ. Tranſact.* N° 336.

CHAP. III.

Of the Subterraneous Caverns, and the Vulcanos.

I Shall take Notice of the ſubterraneous Caverns, Grottos and Vulcanos, becauſe they are made an Objection (*a*) againſt the preſent Contrivance and Structure

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(*a*) *Nemo dixerit terram pulchriorem eſſe quod cavernoſa fiet, quòd dehiſcat in multis locis, quòd diſrupta caveis & ſpatiis inanibus: iiſque nullo ordine diſpoſitis, nullâ formâ: nec quæ aliud contineant quàm tenebras & ſordes; unde graves & peſtiferæ exhalationes, terræ motus, &c.* Burnet ubi ſupra, cap. 7.

Structure of the Globe. But, if well conſidered, they will be found to be wiſe Contrivances of the Creator, ſerving to great Uſes of the Globe, and Ends of God's Government. Beſides many ſecret, grand Functions and Operations of Nature in the Bowels of the Earth, that in all Probability theſe Things may miniſter unto, they are of great Uſe to the Countries where they are *(b)*. To Inſtance in the very worſt of the Things named, *viz.* the *Vulcano's* and ignivomous Mountains; although they are ſome of the moſt terrible Shocks of the Globe, and dreadful Scourges of the ſinful Inhabitants thereof, and may ſerve them as Emblems, and Preſages of Hell itſelf; yet even theſe have their great Uſes too, being as Spiracles or Tunnels *(c)* to the Countries where they are, to vent the Fire and Vapours that would make diſmal Havock, and oftentimes actually do ſo, by dreadful Succuſſions and Convulſions of the Earth. Nay, if the Hypotheſis of a central Fire and Waters be true, theſe Outlets ſeem to be of greateſt Uſe to the Peace and Quiet of the Terraqueous Globe, in venting the ſubterraneous Heat and Vapours; which, if pent up,

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(b) The *Zirchnitzer* Sea, in *Carniola*, is of great Uſe to the Inhabitants of that Country, by affording them Fiſh, Fowls, Fodder, Seeds, Deer, Swine, and other Beaſts, Carriage for their Goods, *&c.* *Vide Phil. Tranſ.* N° 191, *&c.* or *Lowth. Abridg.* vol. ii. p. 306, *&c.* where you have put together in one View, what is diſperſed in divers of the *Tranſactions.* This Sea or Lake proceeds from ſome ſubterraneous Grotto, or Lake, as is made highly probable by Mr. *Valvaſor. Ibid.*

The *Grotto Podpetſchio* may be another Inſtance, that the very ſubterraneous Lakes may be of Uſe, even to the Inhabitants of the Surface above: of which ſee *Lowth. ubi ſupra*, p, 317. *Sturmius* may alſo be conſulted here, in his *Philoſoph. Eclect. Exercit.* 11. *de Terræ mot.* particularly in *Chap.* 3. ſome of the moſt eminent Specuſes are enumerated, and ſome of their Uſes.

(c) Crebri ſpecus [remedium] *præbent. Præconceptum enim ſpiritum exhalant: quod in certis notatur oppidis, quæ minùs quatiuntur, crebris ad eluviem cuniculis cavata.* Plin. Hiſt. Nat. lib. ii. cap. 82.

would make dreadful and dangerous Commotions of the Earth and Waters.

It may be then accounted as a ſpecial Favour of the divine Providence, as is obſerved by the Author before praiſed *(d)*, " That there are ſcarcely any " Countries, that are much annoyed with Earthquakes, that have not one of theſe fiery Vents. " And theſe (ſaith he) are conſtantly all in Flames " whenever any Earthquake happens, they diſgorging that Fire, which whilſt underneath, was the " Cauſe of the Diſaſter. Indeed, (ſaith he) were " it not for theſe *Diverticula*, whereby it thus gaineth an *Exit*, it would rage in the Bowels of the " Earth much more furiouſly, and make greater " Havock than now it doth. So that, tho' thoſe " Countries, where there are ſuch *Vulcanos*, are " uſually more or leſs troubled with Earthquakes; " yet, were theſe *Vulcanos* wanting, they would be " much more annoyed with them than now they " are, yea, in all Probability to that Degree, as to " render the Earth, for a vaſt Space around them, " perfectly uninhabitable. In one Word, (ſaith he) " ſo beneficial are theſe to the Territories where " they are, that there do not want Inſtances of ſome " which have been reſcued, and wholly delivered " from Earthquakes by the breaking forth of a new " *Vulcano* there; this continually diſcharging that " Matter, which being till then barricaded up, and " impriſoned in the Bowels of the Earth, was the " Occaſion of very great and frequent Calamities." Thus far that ingenious Author.

(d) Woodward's Eſſay, Part iii. Conſect. 13.

CHAP. IV.

Of the Mountains and Valleys.

THE laſt Thing I ſhall take Notice of relating to the Earth, ſhall be the *Hills* and *Valleys.* Theſe the eloquent *Theoriſt* owns to "contain ſomewhat "auguſt and ſtately in the beholding of them, that "inſpireth the Mind with great Thoughts and Paſ"ſions, that we naturally on ſuch Occaſions think "of God and his Greatneſs." But then, at the ſame Time, he ſaith, "The Hills are the greateſt "Examples of Ruin and Confuſion; that they have "neither Form nor Beauty, nor Shape, nor Or"der, any more than the Clouds in the Air; that "they conſiſt not of any Proportion of Parts, re"ferable to any Deſign, nor have the leaſt Foot"ſteps of Art or Counſel." Conſequently one grand Part of this lower Creation, even the whole preſent Face of our Terraqueous Globe, according to this ingenious Author, is a Work of mere Chance, a Structure in which the Creator did not concern himſelf.

Part of this Charge I have already briefly anſwered, and my Survey now leads me to ſhew, that the Mountains are ſo far from being a Blunder of Chance, a Work without Deſign, that they are a noble, uſeful, yea, a neceſſary Part of our Globe *(a)*.

And

(a) Though there are ſome that think Mountains to be a Deformity to the Earth, &c. *yet if well conſidered, they will be found as much to conduce to the Beauty and Convenience of the Univerſe, as any of the other Parts. Nature* (ſaith *Pliny) purpoſely framed them*

And in the firſt Place, as to the Buſineſs of Ornament, Beauty, and Pleaſure, I may appeal to all Men's Senſes, whether the grateful Variety of Hills and Dales, be not more pleaſing than the largeſt continued Planes. Let thoſe who make it their Buſineſs to viſit the Globe, to divert their Sight with the various Proſpects of the Earth; let theſe, I ſay, judge whether the far diſtant Parts of the Earth would be ſo well worth viſiting, if the Earth was every where of an even, level, globous Surface, or one large Plane of many 1000 Miles; and not rather, as now it is, whether it be not far more pleaſing to the Eye, to view from the Tops of the Mountains the ſubjacent Vales and Streams, and the far diſtant Hills; and again from the Vales to behold the ſurrounding Mountains. The elegant Strains and lofty Flights, both of the antient and modern Poets on theſe Occaſions, are Teſtimonies of the Senſe of Mankind on this Configuration of the Earth.

But be the Caſe as it will as to Beauty, which is the leaſt valuable Conſideration, we ſhall find as to Convenience, this Configuration of the Earth far the moſt commodious on ſeveral Accounts.

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them for many excellent Uſes; partly to tame the Violence of greater Rivers, to ſtrengthen certain Joints within the Veins and Bowels of the Earth, to break the Force of the Sea's Inundation, and for the Safety of the Earth's Inhabitants, whether Beaſts or Men. That they make much for the Protection of Beaſts, the Pſalmiſt teſtifies, The higheſt Hills are a Refuge for the wild Goats, and the Rocks for Conies. *The Kingly Prophet had likewiſe learned the Safety of thoſe by his own Experience, when he alſo was fain to make a Mountain his Refuge from the Fury of his Maſter* Saul, *who proſecuted him in the Wilderneſs. True indeed, ſuch Places as theſe keep their Neighbours poor, as being moſt barren, but yet they preſerve them ſafe, as being moſt ſtrong; witneſs our Unconquered* Wales *and* Scotland. — *Wherefore a good Author doth rightly call them* Nature's Bulwarks, *caſt up at God Almighty's Charges, the Scorns and Curbs of victorious Armies; which made the* Barbarians *in* Curtius *ſo confident of their own Safety,* &c. *Wilkins*'s World in the Moon, p. 114.

1. As it is the moſt ſalubrious, of great Uſe to the Preſervation or Reſtoration of the Health of Man. Some Conſtitutions are indeed of ſo happy a Strength, and ſo confirmed an Health, as to be indifferent to almoſt any Place or Temperature of the Air: But then others are ſo weakly and feeble, as not to be able to bear one, but can live comfortably in another Place. With ſome, the finer and more ſubtile Air of the Hills doth beſt agree, who are languiſhing and dying in the feculent and groſſer Air of great Towns, or even the warmer, and vaporous Air of the Valleys and Waters: But contrarywiſe others languiſh on the Hills, and grow luſty and ſtrong in the warmer Air of the Valleys,

So that this Opportunity of ſhifting our Abode from the warmer and more vaporous Air of the Valleys, to the colder and more ſubtile Air of the Hills, or from the Hills to the Vales, is an admirable Eaſement, Refreſhment, and great Benefit to the valetudinarian, feeble part of Mankind, affording thoſe an eaſy and comfortable Life, who would otherwiſe live miſerably, languiſh, and pine away,

2. To this ſalutary Conformation of the Earth, we may add another great Convenience of the Hills, and that is in affording commodious Places for Habitation: " Serving (as an eminent Author *(b)* wordeth it) " as Skreens to keep off the cold and " nipping Blaſts of the Northerly and Eaſterly " Winds, and reflecting the benign and cheriſhing " Sun-beams, and ſo rendering our Habitations " both more comfortable and more chearly in " Winter; and promoting the Growth of Herbs " and Fruit-Trees, and the Maturation of the " Fruits in Summer.

3. Another Benefit of the Hills is, that they ſerve for the Production of great Varieties of Herbs and

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(b) Ray's *Wiſdom of God,* &c. *p.* 251. *Diſſolution of the World, p.* 35.

Trees *(c)*. And as there was not a better Judge of thoſe Matters, ſo I cannot give a better Account of this Convenience, than in the Words of the laſt cited famous Author, the late moſt eminent and learned Mr. *Ray (d)*, (who hath ſo fully diſcuſſed this Subject I am upon, that it is ſcarce poſſible to tread out of his Steps therein.) His Obſervation is, "That the Mountains do eſpecially abound with "different Species of Vegetables, becauſe of the "great Diverſity of Soils that are found there, eve"ry *Vertex*, or Eminence almoſt, affording new "Kinds. Now theſe Plants (ſaith he) ſerve partly, "for the Food and Suſtenance of ſuch Animals as "are proper to the Mountains, partly for medicinal "Uſes; the chief Phyſick, Herbs and Roots, and "the beſt in their Kinds growing there: It being "remarkable, that the greateſt and moſt luxurious "Species in moſt Genera of Plants are natives of the "Mountains.

4. Another Convenience which my laſt named learned Friend obſerves *(e)* is, "That the Moun"tains ſerve for the Harbour, Entertainment, and "Maintenance of various Animals, Birds, Beaſts "and Inſects, that breed, feed, and frequent there. "For, (ſaith he,) the higheſt Tops and Pikes of "the *Alpes* themſelves are not deſtitute of their In"habitants, the *Ibex* or *Stein-buck*, the *Rubicapra* "or *Chamois*, among Quadrupeds; the *Lagopus* a"mong Birds. And I my ſelf (ſaith he) have ob-

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(c) Theophraſtus having reckoned up the Trees that delight moſt in the Hills, and others in the Valleys, obſerveth, Ἅπαντα δὲ ὅσα κοινὰ τῶν ὀρῶν ϗ τῶν ϖεδίων, μείζω μὲν ϗ ϖαλλίω τῇ ὄψει τὰ ἐν τοῖς ϖεδίοις γίνεται· κρείττω δὲ τῇγε χρήσει τῶν ξύλων ϗ τῶν καρπῶν, τὰ ὀρεινά. *Theoph. Hiſt. Pl.* lib. iii. cap. 4. Ἅπαντα δὲ ἐν τοῖς οἰκείοις τόποις καλλίω γίνεται, ϗ μᾶλλον εὐσθενεῖ. — Τὰ μὲν γὰρ φιλεῖ τȣ̃ς ἐφύδρȣς ϗ ἑλώδεις. — Τὰ δὲ, τȣ̀ς εὐσκεπεῖς ϗ εὐηλίȣς. *Ibid.* lib. iv. cap. 1.

(d) Wiſdom of God, p. 252.

(e) Ubi ſupra.

“ ſerved beautiful *Papilio's*, and Store of other Inſects upon the Tops of ſome of the *Alpine* Mountains. Nay, the higheſt Ridges of many of theſe Mountains, ſerve for the Maintenance of Cattle, for the Service of the Inhabitants of the Valleys.”

5. Another Thing he obſerves is, “ That thoſe long Ridges and Chains of lofty and topping Mountains, which run through whole Continents Eaſt and Weſt (*f*), ſerve to ſtop the Evagation of the Vapours to the North and South in hot Countries, condenſing them like Alembick-Heads into Water, and ſo (according to his Opinion) by a kind of external Diſtillation giving Original to Springs and Rivers; and likewiſe by amaſſing, cooling and conſtipating of them, turn them into Rain, by thoſe Means rendering the fervid Regions of the torrid Zone habitable.”

To theſe might be added ſome other Uſes and Conveniences (*g*); as that the Hills ſerve to the Genera-

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(*f*) Many have taken Notice, that ſome of the greateſt Eminences of the World run generally Eaſt and Weſt, of which, take the late ingenious and learned Dr. *Nichols*'s Account, [*Confer. with a Theiſt*, Part ii. p. 191.] *To go no farther than our own Country, all our great Ridges of Hills in* England *run Eaſt and Weſt*; *ſo do the* Alps *in* Italy, *and in ſome Meaſure the* Pyrenees; *ſo do the Mountains of the Moon in* Africk, *and ſo do Mount* Taurus *and* Caucaſus. *This* (he ſaith) *is a wiſe Contrivance to prevent the Vapours, which would all run Northwards, and leave no Rains in the* Mediterranean *Countries.*

(*g*) That the Generation of many of the Clouds is owing to the Hills, appears from the Obſervations of the ingenious and learned Dr. *Joh. Jam. Scheuchzer* of *Zurich*, and Mr. *Joach. Frid. Creitlovius* cited by him. They obſerved at Sun-riſing, divers Clouds detached by the Heat of the Sun, from ſome of the Tops of the *Alpes*, &c. upon all which their Obſervations, the Concluſion is, *Mirati ſummam Creatoris ſapientiam, qui & id quod paulò antè nulli nobis uſui eſſe videbatur, maximis rebus deſtinaverat, adeòque ex illo tempore dubitare cœpi, num Nubes eſſent futuræ, ſi iſtiuſmodi Montes & Petræ non darentur. Hypotheſi hâc ſtante, eluceſceret permagna utilitas, imò neceſſitas, quam*

Helviticæ

Generation of Minerals and Metals *(b)*, and that in them principally are the moſt uſeful Foſſiles found; or if not found and generated only in them, yet at leaſt all theſe ſubterraneous Treaſures are moſt eaſily come at in them: Alſo their Uſe to ſeveral Nations of the Earth, in being Boundaries and Bulwarks to them. But there is only one Uſe more that I ſhall inſiſt on; and that is,

6. And laſtly, That it is to the Hills that the Fountains owe their Riſe, and the Rivers their Conveyance. As it is not proper, ſo neither ſhall I here enter into any Diſpute about the Origin of Springs, commonly aſſigned by curious and learned Philoſophers. But whether their Origin be from condenſed Vapours, as ſome think *(i)*; or from Rains falling, as others; or whether they are derived from the Sea by way of Attraction, Percolation, or Diſtillation; or whether all theſe Cauſes concur, or only ſome, ſtill the Hills are the grand Agent in this prodigious Benefit to all the Earth: Thoſe vaſt Maſſes and Ridges of Earth ſerving as ſo many huge *Alembicks* or *Cola* in this noble Work of Nature.

But be the *Modus*, or the Method Nature takes in this great Work as it will, it is ſufficient to my Purpoſe, that the Hills are a grand Agent in this ſo no-

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Helviticæ Alpes *non nobis tantùm accolis ſed & vicinis aliis regionibus præſtant, diſpenſando, quas gignunt Nubes, Ventos, Aquas.* Scheuch. Iter. Alpin. 2. p. 20.

(b) Let us take here *Ol. Mag.* Obſervation of his Northern Mountains; *Montes excelſi ſunt, ſed pro majori parte ſteriles, & aridi; in quibus ferè nil aliud pro incolarum commoditate & conſervatione gignitur, quam inexhauſta pretioſorum Metallorum ubertas, quâ ſatis opulenti, fertileſque ſunt in omnibus vitæ neceſſariis, forſitan & ſuperfluis aliunde ſi libet conquirendis, unanimique robore, ac viribus, ubi vis contra hæc naturæ dona intentata fuerit, defendendis. Acre enim genus hominum eſt, &c.* Ol. Mag. Hiſt. lib. vi. Præf. See alſo Sir *Robert Sibbald*'s Prodr. Nat. Hiſt. Scot. p. 47.

(i) Book I. *Chap.* iii. *Note (b).*

ble and neceſſary a Work: And conſequently, that thoſe vaſt Maſſes, and lofty Piles, are not, as they are charged, ſuch rude and uſeleſs Excreſcences of our ill-formed Globe; but the admirable Tools of Nature, contrived and ordered by the infinite Creator, to do one of its moſt uſeful Works, and to diſpenſe this great Bleſſing to all Parts of the Earth; without which neither Animals could live, nor Vegetables ſcarcely grow, nor perhaps Minerals, Metals, or Foſſiles receive any Increaſe. For was the Surface of the Earth even and level, and the Middle Parts of its Iſlands and Continents not mountainous and high (as now it is) it is moſt certain there could be no Deſcent for the Rivers, no Conveyance for the Waters; but inſtead of gliding along thoſe gentle Declivities which the Higher Lands now afford them quite down to the Sea, they would ſtagnate, and perhaps ſtink, and alſo drown large Tracts of Land.

But indeed, without Hills, as there could be no Rivers, ſo neither could there be any Fountains, or Springs about the Earth; becauſe, if we could ſuppoſe a Land could be well watered (which I think not poſſible) without the higher Lands, the Waters could find no Deſcent, no Paſſage through any commodious Out-lets, by Virtue of their own Gravity; and therefore could not break out into thoſe Commodious Paſſages and Currents, which we every where almoſt find in, or near the Hills, and ſeldom or never, in large and ſpacious Plains; and when we do find them in them, it is generally at great and inconvenient Depths of the Earth; nay, thoſe very ſubterraneous Waters, that are any where met with by digging in theſe Plains, are in all Probability owing to the Hills, either near or far diſtant: As among other Inſtances may be made out, from the forcible Eruption of the ſubterraneous Waters in digging Wells, in the *Lower Auſtria*, and the Territories of *Modena*, and *Bologna* in *Italy*, mentioned by my fore-named learned Friend Mr. *Ray*(*k*). Or if there be any ſuch Place found throughout the Earth, that is devoid of Mountains, and yet well watered, as perhaps ſome ſmall Iſlands may; yet in this very Caſe, that whole Maſs of Land is no other than as one Mountain deſcending (though unperceivedly) gently down from the Mid-land Parts to the Sea, as moſt other Lands do; as is manifeſt from the Deſcent of their Rivers, the Principal of which in moſt Countries have generally their Riſe in the more lofty Midland Parts.

And now, conſidering what hath been ſaid concerning this laſt Uſe of the Hills, there are two or three Acts of the Divine Providence obſervable therein. One is, that all Countries throughout the whole World, ſhould enjoy this great Benefit of Mountains, placed here and there, at due and pro-

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(*k*) *Monſieur* Blundel *related to the* Pariſian *Academy what Device the Inhabitants of the* Lower Auſtria, (*which is encompaſſed with the Mountains of* Stiria) *are wont to uſe to fill their Wells with Water. They dig in the Earth to the Depth of* 25 *and* 20 *Feet, till they come to an Argilla* [clammy Earth] — *which they bore through ſo deep, till the Waters break forcibly out; which Water, it is probable, comes from the neighbouring Mountains in ſubterraneous Channels. And* Caſſinus *obſerved, That in many Places in the Territory of* Modena *and* Bologna *in* Italy, *they make themſelves Wells by the like Artifice,* &c. *By this Means the ſame* Seig. Caſſini *made a Fountain at the Caſtle of* Urbin, *that caſt up the Water* 5 *Feet high above the Level of the Ground.* Ray's Diſc. p. 40. ubi plura.

Upon Enquiry of ſome ſkilful Workmen, whoſe Buſineſs it is to dig Wells, *&c.* whether they had ever met with the like Caſe, as theſe in this Note; they told me they had met with it in *Eſſex*, where, after they had dug to 50 Feet Depth, the Man in the Well obſerved the clayie Bottom to ſwell and begin to ſend out Water, and ſtamping with his Foot to ſtop the Water, he made Way for ſo ſudden and forcible a Flux of Water, that before he could get into his Bucket, he was above his Waiſt in Water; which ſoon aſcended to 17 Feet Height, and there ſtaid: And although they often, with great Labour, endeavoured to empty the Well, in order to finiſh their Work, yet they could never do it, but were forced to leave it as it was.

per Diſtances, to afford theſe ſeveral Nations this excellent and moſt neceſſary Element the Waters. For, according to Nature's Tendency, when the Earth and Waters were ſeparated, and order'd to their ſeveral Places, the Earth muſt have been of an even Surface, or nearly ſo. The ſeveral component Parts of the Earth muſt have ſubſided according to their ſeveral ſpecifick Gravities, and at laſt have ended in a large, even, ſpherical Surface, every where equidiſtant from the Centre of the Globe. But that inſtead of this Form, ſo incommodious for the Conveyance of the Waters, it ſhould be jetted out every where into Hills and Dales, ſo neceſſary for that Purpoſe, is a manifeſt Sign of an eſpecial Providence of the wiſe Creator.

So another plain Sign of the ſame eſpecial Providence of God, in this Matter, is, that generally throughout the whole World, the Earth is ſo diſpoſed, ſo ordered, ſo well-laid; I may ſay, that the Mid-land Parts, or Parts fartheſt from the Sea, are commonly the higheſt: Which is manifeſt, I have ſaid, from the Deſcent of the Rivers. Now this is an admirable Proviſion the wiſe Creator hath made for the commodious Paſſages of the Rivers, and for draining the ſeveral Countries, and carrying off the ſuperfluous Waters from the whole Earth, which would be as great an Annoyance, as now they are a Convenience.

Another providential Benefit of the Hills ſupplying the Earth with Water, is, that they are not only inſtrumental thereby, to the Fertility of the Valleys, but to their own alſo *(l)*; to the Verdure of the Vegetables

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(l) As the Hills being higher, are naturally ſuppoſed to be drier than the Valleys; ſo kind Nature hath provided the greater Supplies of Moiſture for them, ſuch at leaſt of them as do not aſcend above the Clouds and Vapours. For, beſides the Fountains continually watering them, they have more Dews and Rains commonly than the Valleys. They are more frequently

Vegetables without, and to the Increment and Vigour of the Treaſures within them.

Thus having vindicated the preſent Form and Fabrick of the Earth, as diſtributed into Mountains and Valleys, and thereby ſhewn in ſome Meaſure the Uſe thereof, particularly of the Mountains, which are chiefly found Fault with: I have, I hope, made it in ſome Meaſure evident, that God was no idle Spectator *(m)*, nor unconcerned in the ordering of the Terraqueous Globe, as the former bold Charges againſt it do infer; that he did not ſuffer ſo grand a Work, as the Earth, to go unfiniſh'd out of his Almighty Hand; or leave it to be ordered by Chance, by natural Gravity, by caſual Earthquakes, *&c.* but that the noble Strokes, and plain Remains of Wiſdom and Power therein, do manifeſt it to be his Work. That particularly the Hills and Vales, though to a peeviſh weary Traveller, they may ſeem incommodious and troubleſome; yet are a noble Work of the great Creator, and wiſely appointed by him for the Good of our ſublunary World.

And ſo for all the other Parts of the Terraqueous Globe, that are preſumed to be found Fault with by ſome, as if careleſly ordered, and made without any Deſign or End; particularly the Diſtribution of the

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frequently covered with Fogs; and by retarding, ſtopping, or compreſſing the Clouds, or by their greater Colds condenſing them, they have larger Quantities of Rain fall upon them. As I have found by actual Experience, in comparing my Obſervations with thoſe of my late very curious and ingenious Correſpondent, *Richard Townley*, Eſq. of *Lancaſhire*, and ſome others, to be met with before, *Chap.* ii. *Note (a).* From which it appears, that above double the Quantity of Rain falleth in *Lancaſhire*, than doth at *Upminſter*: The Reaſon of which is, becauſe *Lancaſhire* hath more, and much higher Hills than *Eſſex* hath. See *Book* II. *Chap.* v. *Note (e).*

(m) Accuſandi ſanè meâ ſententiâ hic ſunt Sophiſtæ, qui cùm nondum invenire, neque exponere opera Naturæ queant, eam tamen inertiâ atque inſcitia condemnant, &c. Galen. de Uſu Part. lib. x. cap. 9.

dry Land and Waters; the laying the ſeveral Strata, or Beds of Earth, Stone, and other Layers before ſpoken of; the Creation of noxious Animals, and poiſonous Subſtances, the boiſterous Winds; the Vulcano's, and many other Things which ſome are angry with, and will pretend to amend: I have before ſhewn, that an infinitely wiſe Providence, an Almighty Hand was concerned even in them; that they all have their admirable Ends and Uſes, and are highly inſtrumental and beneficial to the Being, or Well-being of this our Globe, or to the Creatures reſiding thereon.

So alſo for human Bodies, it hath been an ancient *(n)*, as well as modern Complaint, that our Bodies are not as big as thoſe of other Animals; that we cannot run as ſwift as Deer, fly like Birds, and that we are out-done by many Creatures in the Accuracy of the Senſes, with more to the ſame Purpoſe. But theſe Objections are well anſwered by *Seneca (o)*, and will receive a fuller Solution from what I ſhall obſerve of Animal Bodies hereafter.

But indeed, after all, it is only for want of our knowing theſe Things better, that we do not admire

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(n) Vide quàm iniqui ſint divinorum munerum æſtimatores etiam quidam profeſſi ſapientiam. Queruntur quòd non magnitudine corporis æquemus Elephantes, velocitate Cervos, levitate Aves, impetu Tauros; quòd ſolidior ſit cutis Belluis, decentior Damis, denſior Urſis, mollior Fibris; quòd ſagacitate nos narium Canes vincant, quòd acie luminum Aquilæ, ſpatio ætatis Corvi, multa Animalia nandi facilitate. Et cum quædam nè coire quidem in idem Natura patiatur, ut velocitatem corporis & vires pares animalibus habeamus; ex diverſis & diſſidentibus bonis Hominem non eſſe compoſitum, injuriam vocant; & in negligentes noſtri Deos querimoniam faciunt, quod non bona valetudo, & vitiis inexpugnabilis data ſit, quòd non futuri ſcientia. Vix ſibi temperant quin eouſque impudentiæ provehantur, ut Naturam oderint, quòd infra Deos ſumus, quòd non in æquo illis ſtetimus. Seneca de Benef. lib. ii. cap. 29.

(o) Quanto ſatiùs eſt ad contemplationem tot tantorumque beneficiorum reverti, & agere gratias, quòd nos in hoc pulcherri-

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admire (*p*) them enough; it is our own Ignorance, Dulneſs, or Prejudice, that makes us charge thoſe noble Works of the Almighty, as Defects or Blunders, as ill-contrived, or ill-made.

It is therefore fitter for ſuch finite, weak, ignorant Beings as we, to be humble and meek, and conſcious of our Ignorance, and jealous of our own Judgment, when it thus confronteth infinite Wiſdom. Let us remember how few Things we know, how many we err about, and how many we are ignorant of: And thoſe, many of them, the moſt familiar, obvious Things: Things that we ſee and handle at Pleaſure; yea, our own very Bodies, and that very Part of us whereby we underſtand at all, our Soul. And ſhould we therefore pretend to cenſure what God doth! Should we pretend to amend his Work! Or to adviſe infinite Wiſdom! Or to know the Ends and Purpoſes of his infinite Will, as if we were of his Council! No, let us bear in Mind, that theſe Objections are the Products, not of Reaſon, but of Peeviſhneſs. They have been incommoded by Storms and Tempeſts; they have been terrified with the burning Mountains, and Earthquakes; they have been annoyed by the noxious Animals, and fatigued by the Hills; and therefore are angry, and will pretend to amend theſe Works of the Almighty. But in the Words of St. *Paul* (*q*), we may ſay, *Nay, but O Man, who art thou that replieſt againſt God? Shall the Thing formed ſay to him that formed it, Why haſt thou made me thus?*

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mo domicilio voluerunt [Dii] *ſecundos ſortiri, quòd terrenis præfecerunt.* Then having reckoned up many of the Privileges and Benefits, which the Gods, he ſaith, have conferred upon us, he concludes, *Ita eſt: cariſſimos nos habuerunt Dii immortales, habentque. Et qui maximus tribui bonos potuit, ab ipſis proximos collocaverunt. Magna accepimus, majora non cepimus.* Senec. ibid.

(*p*) *Naturam maximè admiraberis, ſi omnia ejus opera perluſtrâris.* Galen. de Uſ. Part. lib. xi. concluſ.

(*q*) Rom. ix. 20, 21.

Hath not the Potter power over the Clay, of the ſame Lump, to make one Veſſel to Honour, and another to Diſhonour? If the Almighty Lord of the World had, for his own Pleaſure, made this our World more inconvenient for Man, it would better become us to ſit ſtill, and be quiet; to lament our own great Infirmities and Failings, which deſerve a worſe Place, a more incommodious Habitation, than we meet with in this elegant, this well contrived, well formed World; in which we find every Thing neceſſary for the Suſtentation, Uſe, and Pleaſure, both of Man, and every other Creature here below, as well as ſome Whips, ſome Rods to ſcourge us for our Sins (*r*). But yet ſo admirably well tempered is our State, ſuch an Accord, ſuch an Harmony is there throughout the Creation, that if we will but purſue the Ways of Piety and Virtue, which God hath appointed; if we will form our Lives according to the Creator's Laws, we may eſcape the Evils of this our frail State, and find ſufficient Means to make us happy whilſt we are in the Body. The natural Force and Tendency of our Virtue, will prevent many of the Harms (*s*), and the watchful Provi-

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(*r*) *Neither are they* [noxious Creatures] *of leſs Uſe to amend our Minds, by teaching us Care and Diligence, and more Wit. And ſo much the more, the worſe the Things are we ſee, and ſhould avoid.* Weezels, Kites, *and other miſchievous Animals, induce us to a Watchfulneſs:* Thiſtles *and* Moles, *to good Huſbandry;* Lice *oblige us to Cleanlineſs in our Bodies;* Spiders, *in our Houſes; and the* Moth *in our Cloaths. The Deformity and Filthineſs of* Swine *make them the Beauty-Spot of the Animal-Creation, and the Emblems of all Vice. — The Truth is, Things are hurtful to us only by Accident; that is, not of Neceſſity, but through our own Negligence or Miſtake. Houſes decay, Corn is blaſted, and the Weezel breeds in Malt, ſooneſt towards the South. Be it ſo, it is then our own Fault, if we uſe not the Means which Nature and Art have provided againſt theſe Inconveniencies.* Grew's Coſmol. chap. ii. ſect 49, 50.

(*s*) *Non eſt gemendus, nec gravi urgendus nece,*
Virtute quiſquis abſtulit fatis iter.
Senec. Hercul. Oet. Act. v. Car. 1833.

Providence of our Almighty Benefactor, will be a Guard againſt others; and then nothing is wanting to make us happy, as long as we are in this World, there being abundantly enough to entertain the Minds of the moſt Contemplative; Glories enough to pleaſe the Eye of the moſt Curious and Inquiſitive; Harmonies and Concerts of Nature's own, as well as Man's making, ſufficient to delight the Ear of the moſt Harmonious and Muſical; all ſorts of pleaſant Guſto's to gratify the Taſte and Appetite, even of the moſt Luxurious; and fragrant Odours to pleaſe the niceſt and tendereſt Smell: And, in a word, enough to make us love and delight in this World, rather too much, than too little, conſidering how nearly we are ally'd to another World, as well as this.

Nunquam Stygias fertur ad umbras
Inclyta virtus. Id. ibid. Car. 1982.

BOOK IV.

Of Animals in General.

IN the laſt Book, having ſurveyed the Earth itſelf in Particular, I ſhall next take a View of the Inhabitants thereof; or the ſeveral Kinds of Creatures (*a*), that have their Habitation, Growth, or Subſiſtence thereon. Theſe Creatures are either Senſitive, or Inſenſitive Creatures.

In ſpeaking of thoſe endow'd with Senſe, I ſhall conſider:

I. Some Things common to them all.
II. Things peculiar to their Tribes.

I. The Things in common, which I intend to take Notice of, are theſe Ten:

1. The five *Senſes*, and Their Organs.
2. The great Inſtrument of Vitality, *Reſpiration*.
3. The *Motion*, or Loco-motive Faculty of Animals.

(*a*) *Principio cælum, ac terras, campoſque liquentes,*
Lucentemque globum Lunæ, Titaniaque aſtra
Spiritus intùs alit, totamque infuſa per artus
Mens agitat molem, & magno ſe corpore miſcet.
Inde hominum, pecudumque genus, vitæque volantum,
Et quæ marmoreo fert monſtra ſub æquore pontus,
Igneus eſt illis vigor, & cæleſtis origo
Seminibus.
Virg. Æneid. lib. vi. carm. 724.

4. The *Place*, in which they live and act.
5. The *Balance* of their Numbers.
6. Their *Food*.
7. Their *Cloathing*.
8. Their *Houſes*, *Neſts* or *Habitations*.
9. Their Methods of *Self-Preſervation*.
10. Their *Generation* and *Conſervation* of their Species by that Means.

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CHAP. I.

Of the Five Senſes in General.

THE firſt Thing to be conſider'd, in common to all the Senſitive Creatures, is, their Faculty of *Seeing*, *Hearing*, *Smelling*, *Taſting*, and *Feeling*; and the *Organs* miniſtring to theſe five *Senſes*, together with the exact Accommodation of thoſe Senſes, and their Organs, to the State and Make of every Tribe of Animals (*a*). The Conſideration of which Particulars alone, were there no other Demonſtrations of God, is abundantly ſufficient to evince the infinite Wiſdom, Power and Goodneſs, of the great Creator. For, who can but ſtand amazed at the Glories of theſe Works! At the admirable Artifice of them! And at their noble Uſe and Performances! For ſuppoſe an Animal, as ſuch, had Breath and Life, and could move itſelf hither and thither; yet how could it know whither to go, what it was about, where to find its Food, how to avoid thou-

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(a) *Ex ſenſibus ante cætera Homini Tactus, deinde Guſtatus: reliquis ſuperatur à multis. Aquilæ clariùs cernunt: Vultures ſagaciùs odorantur, liquidiùs audiunt Talpæ obrutæ terrâ, tam denſo atque ſurdo naturæ elemento.* Plin. Nat. Hiſt. lib. x. cap. 69.

ſands of Dangers (*b*) without Sight! How could Man, particularly, view the Glories of the Heavens, ſurvey the Beauties of the Fields, and enjoy the Pleaſure of beholding the noble Variety of diverting Objects, that do, above us in the Heavens, and here in this lower World, preſent themſelves to our View every where; how enjoy this, I ſay, without that admirable Senſe of *Sight* (*c*)! How could alſo the Animal, without *Smell* and *Taſte*, diſtinguiſh its Food, and diſcern between wholſome and unwholſome; beſides the Pleaſures of delightful Odours, and reliſhing Guſto's! How, without that other Senſe of *Hearing*, could it diſcern many Dangers that are at a Diſtance, underſtand the Mind of others, perceive the harmonious Sounds of Muſick, and be delighted with the Melodies of the winged Choir, and all the reſt of the Harmonies the Creator hath provided for the Delight and Pleaſure of his Creatures! And laſtly, How could Man, or any other Creature, diſtinguiſh Pleaſure from Pain, Health from Sickneſs, and conſequently be able to keep their Body ſound and entire, without the Senſe of *Feeling!* Here, therefore, we have a glorious Œconomy in every Animal, that commandeth Admiration, and deſerveth our Contemplation: As will better appear by coming to Particulars, and diſtinctly conſidering the Proviſion which the Creator hath made for each of theſe Senſes.

(*b*) *Subjacent Oculi, pars corporis pretioſiſſima, & qui lucis uſu vitam diſtinguant a morte.* Plin. Nat. Hiſt. lib. xi. cap. 37.

(*c*) *Fæminæ aliquæ Megarenſes ſolis oculis diſcernere valebant inter Ova quæ ex Gallinâ nigrâ, & quæ ex albâ nata ſunt,* is what is affirmed (how truly I know not) by *Grimald. de Lumin. & Color. Pr.* 43. *Sect.* 60.

CHAP. II.

Of the Eye.

FOR our clearer Proceeding in the Conſideration of this noble Part (*a*), and underſtanding its Œconomy, I ſhall conſider:

1. The *Form* of the Eye.
2. Its *Situation* in the Body.
3. Its *Motions*.
4. Its *Size*.
5. Its *Number*.
6. Its *Parts*.
7. The *Guard* and *Security* Nature hath provided for this ſo uſeful a Part.

As this eminent Part hath not been pretermitted by Authors, that have made it their particular Deſign and Buſineſs to ſpeak of the Works of GOD; ſo divers of the aforeſaid Particulars have been touched upon by them. And therefore I ſhall take

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(*a*) *In Diſſectionibus anatomicis vix aliquid admirabilius, aut artificioſius ſtructurâ Oculi humani, meo quidem judicio, occurrit: ut meritò, per excellentiam, Creatoris appelletur Miraculum.* Gul. Fabr. Hildan. Cent. 2. Obſerv. 1.

So likewiſe that accurate Surveyor of the Eye, Dr. *Briggs*, whoſe *Ophthalmography* I have met with ſince my penning this Part of my Survey. His Character of this curious Piece of God's Work is, *Inter præcipuas corporis animati partes, quæ magni Conditoris noſtri ſapientiam oſtendunt, nulla ſanè reperitur, quæ majori pompâ elucet quàm ipſe Oculus, aut quæ elegantiori formà concinnatur. Deum enim aliæ partes vel minori ſatellitio ſtipantur, vel in tantam venuſtatem haud aſſurgunt; Ocelli peculiarem honorem & decus à ſupremo Numine efflatum referunt, & nunquam non ſtupendæ ſuæ Potentiæ characteres repræſentant. Nulla ſanè pars tum divino artificio & ordine, &c.* Cap. i. ſect. 1.

in as little as poſſible of what they have ſaid, and as near as I can, mention chiefly what they have omitted. And,

1. For the *Form* of the Eye; which is for the moſt part Globous, or ſomewhat of the ſphæroidal Form, which is far the more commodious optical Form, as being fitteſt to contain the Humours within, and to receive the Images of Objects from without (*b*). Was it a Cube, or of any multangular Form, ſome of its Parts would lie too far off (*c*), and ſome too nigh thoſe lenticular Humours, which by their Refractions cauſe Viſion. But by means of the Form before-mentioned, the Humours of the Eye are commodiouſly laid together, to perform their Office of Refraction; and the *Retina*, and every other

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(*b*) It is a good Reaſon *Friar Bacon* aſſigns for the Sphæricity of the Eye; *Nam ſi eſſet planæ figuræ, ſpecies rei majoris oculo non poſſet cadere perpendiculariter ſuper eum — Cùm ergo Oculus videt magna corpora, ut ferè quartam cæli uno aſpectu, manifeſtum eſt, quòd non poteſt eſſe planæ figuræ, nec alicujus niſi ſphæricæ, quoniam ſuper Sphæram parvam poſſunt cadere perpendiculares infinitæ, quæ à magno corpore veniunt, & tendunt in centrum Sphæræ: & ſic magnum corpus poteſt ab oculo parvo videri.* For the Demonſtration of which he hath given us a Figure. *Rog. Bacon. Perſpect. Diſtinct.* 4. *cap.* 4.

Dr. *Briggs* ſaith, *Pars antica, (ſive Cornea,) convexior eſt poſticâ: hâc enim ratione radii meliùs in pupillam detorquentur, & Oculi fundus ex alterâ parte in majorem (propter imagines rerum ibidem delineandos) expanditur.* Ibid. Sect. 2.

(*c*) Suppoſe the Eye had the *Retina*, or back Part, flat for the Reception of the Images, as in *Fig.* 1. A B A; it is manifeſt, that if the Extremes of the Image A A were at a due focal Diſtance, the Middle B would be too nigh the Cryſtalline, and conſequently appear confuſed and dim; but all Parts of the *Retina* lying at a due focal Diſtance from the Cryſtalline, as at A C A, therefore the Image painted thereon is ſeen diſtinct and clear. Thus in a dark Room, with a Lens at a Hole in the Window, (which *Sturmius* calls his Artificial Eye, in his *Exercitat. Acad.* one of which he had made for his Pupils, to run any where on Wheels): In this Room, I ſay, if the Paper that receives the Images be too nigh, or too far off the Lens, the Image will be confuſed and dim; but in the Focus of the Glaſs, diſtinct, clear, and a pleaſant Sight, Part of that little darken'd Cell, is neatly adapted regularly to receive the Images from without, and to convey them accordingly to the common Senſory in the Brain.

To this we may add the Aptitude of this Figure to the Motion of the Eye, for it is neceſſary for the Eye to move this way, and that way, in order to adjuſt itſelf to the Objects it would view; ſo by this Figure it is well prepared for ſuch Motions, ſo that it can with great Facility and Dexterity direct itſelf as Occaſion requires.

And as the Figure, ſo no leſs commodious is,

2. The *Situation* of the Eye; namely, in the Head (d), the moſt erect, eminent Part of the Body, near the moſt ſenſible, vital Part, the Brain. By its Eminence in the Body, it is prepared to take in the more (e) Objects. And by its Situation in the Head, beſides its Proximity to the Brain, it is in the moſt convenient Place for Defence and Security. In the Hands, it might indeed (in Man) be rendered more eminent than the Head, and be turned about here and there at Pleaſure: But then it would be expoſed to many Injuries in that active Part, and the Hands (f) rendered a leſs active and uſeful Part. And the like may be ſaid to its Sight, in any other Part of the Body, but where it is. But in the Head, both of Man, and other Animals, it is placed in a Part that ſeems to be contriv-

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(d) *Blemmyis traduntur capita abeſſe, Ore & Oculis pectore affixis.* Plin. Nat. Hiſt. lib. v. cap. 8. *Occidentem verſus quoſdam ſine cervice Oculos in humeris habentes.* Ibid. lib. vii. cap. 2. From theſe, and other ſuch like Fables, in this laſt cited Chapter of *Pliny*, no doubt our famous Romancer, Sir *J. Mandevile*, had his Romantick Stories related in his Travels.

(e) See *Book* V. *Chap.* ii. *Note (e).*

(f) *Galen* deſerves to be here conſulted, who, in his Book *De Uſu Partium*, from many Conſiderations of the Hand, ſuch as what is here mentioned, as alſo its Structure, Site, and Uſe, largely proves and reflects upon the Wiſdom and Providence of the Contriver and Maker of that Part.

ed and made, chiefly for the Action of the principal Senſes.

Another Thing obſervable in the Sight of the Eye, is the Manner of its Situation in the Head, in the Fore part, or Side-part thereof, according to the particular Occaſions of particular Animals. In Man, and ſome other Creatures, it is placed to look directly forward chiefly; but withal it is ſo ordered, as to take in near the Hemiſphere before it. In Birds, and ſome other Creatures, the Eyes are ſo ſeated, as to take in near a whole Sphere, that they may the better ſeek their Food, and eſcape Dangers. And in ſome Creatures they are ſeated ſo as to ſee beſt behind them *(g)*, or on each Side, whereby they are enabled to ſee their Enemy that purſues them that Way, and ſo make their Eſcape.

And for the Aſſiſtance of the Eyes, and ſome of the other Senſes in their Actions, the Head is generally made to turn here and there, and move as Occaſion requires. Which leads me to the

3. Thing to be remarked upon, the *Motions* of the Eye itſelf. And this is generally upwards, downwards, backwards, forwards, and every Way *(h)*, for the better, more eaſy, and diſtinct Reception of the viſual Rays.

But where Nature any way deviateth from this Method, either by denying Motion to the Eyes, or the Head *(i)*, it is a very wonderful Proviſion ſhe hath

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(g) Thus in *Hares* and *Conies*, their Eyes are very protuberant, and placed ſo much towards the Sides of their Head, that their two Eyes take in nearly a whole Sphere: Whereas in *Dogs* (that purſue them) the Eyes are ſet more forward in the Head, to look that Way more than backward.

(h) Sed lubricos Oculos fecit [Natura] *& mobiles, ut & declinarent ſiquid noceret; & aſpectum, quo vellent, facilè converterent.* Cicer. de Nat. Deor. lib. ii. cap. 57.

(i) The Eyes of Spiders, (in ſome four, in ſome ſix, and in ſome eight) *are placed all in the Fore-front of their Head (which is*

hath made in the Caſe. Thus for a Remedy of this Inconvenience, in ſome Creatures their Eyes are ſet out at a Diſtance *(k)* from the Head, to be circumvolved here and there; or, one this, the other that Way, at Pleaſure. And in Creatures, whoſe Eyes are without Motion, as in divers Inſects; in this Caſe, either they have more than two Eyes, or their Eyes are nearly two protuberant Hemiſpheres, and each Hemiſphere often conſiſting of a prodigious Number of other little Segments of a Sphere *(l)*. By which Means thoſe Creatures are ſo far from be-

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is round, and without any Neck), all diaphanous and tranſparent, like a Locket of Diamonds, &c. *Neither wonder why Providence ſhould be ſo anomalous in this Animal, more than in any other we know of. For,* 1. *Since they, wanting a Neck, cannot move their Head, it is requiſite that Defect ſhould be ſupplied by the Multiplicity of Eyes.* 2. *Since they were to live by catching ſo nimble a Prey as a Fly is, they ought to ſee her every Way, and to take her* per ſaltum *(as they do), without any Motion of the Head to diſcover her: Which Motion would have ſcared away ſo timorous an Inſect.* Power*'s* Microſ. Obſerv. p. 11.

The Eyes of the Cameleon *reſemble a Lens, or Convex-Glaſs, ſet in a verſatile globular Socket, which ſhe turneth backward, or any Way, without moving her Head; and ordinarily the one a contrary or quite different Way from the other.* Dr. *Goddard* in Phil. Tranſ. N° 137.

But what is more extraordinary in this Motion [of the *Cameleon's* Eye] *is to ſee one of the Eyes move, whilſt the other remains immoveable; and the one to turn forward, at the ſame Time that the other looketh behind; the one to look up to the Sky, when the other is fixed on the Ground. And theſe Motions to be ſo extreme, that they do carry the* Pupilla *under the Creſt which makes the Eye-brow, and ſo far into the* Canthi, *or Corners of the Eyes, that the Sight can diſcern whatever is done juſt behind it, and directly before, without turning the Head, which is faſtened to the Shoulders.* Mem. for an Hiſt. in Anatom. Diſſect. at Paris, Diſſ. of Camel. p. 22.

(k) Snails ſend out their Eyes at a Diſtance, they being contained in their four Horns, *like atramentous Spots, fitted to the End of their Horns, or rather to the Ends of thoſe black Filaments or Optick Nerves, which are ſheathed in her Horns,* as Dr. *Power* wordeth it. *Obſerv.* 31. *p.* 36. So the ingenious Dr. *Liſter, Exercit. Anat. Cochl. & Limac.*

(l) See *Book* VIII. *Chap.* iii. *Note (a).*

ing denied any Benefit of that noble and moſt neceſſary Senſe of Sight, that they have probably more of it than other Creatures, anſwerable to the Rapidity of their Flight, and briſk Motion; and to their Inqueſts after Food, Habitation, or Repoſitories of Generation, or ſuch other Neceſſity of the Animal.

4. Another admirable Proviſion in the Eye, is, its Size; in ſome Animals large, in ſome little. It would be endleſs here to enumerate Particulars; as thoſe of Quadrupeds, Birds, Inſects, and other terreſtrial Animals. And as for Fiſhes, they will fall under another Part of my Survey.

I ſhall therefore only take Notice of its Size in one Creature, the *Mole* (m). As the Habitation of that

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(m) *Severinus* is of *Ariſtotle*'s, *Pliny*'s, and *Alb. Magnus*'s Opinion, that the *Mole* hath no Sight: G. *Seger* denies any Humour to be therein, but thinks they may probably ſee, becauſe Nature made nothing in vain. But *Borrichius* ſaith, their Eyes have *appendiculum nerveam in cerebrum euntem, cujus beneficio globuli illi* [the little Eyes] *extra pellem facilè poterant exſeri, retrahique pro arbitrio — In illis oculorum globulis humor aqueus copioſè ſatis natabat; cæterorum non niſi tenue veſtigium*. Blaſ. Anat. Anim. cap. 35.

Et quoniam Natura hoc vitæ genus ipſi deſtinavit, etiam perquàm exiguos Oculos *— dedit eo concilio, ut ii, pretioſiſſima corporis pars, à terræ pulvere nè affligerentur. Ii inſuper pilis tecti, &c. Humores illis oculis inſunt, & tunica nigra, uvea, ſe prodit. Ad hos tramite alio nervus venit.* Schneider in Blaſ. ibid.

Some time ſince I made divers accurate Diſſections of the *Eyes* of *Moles*, with the Help of Microſcopes, having a Doubt whether what we take to be Eyes, were ſuch or no. And upon a ſtrict Scrutiny I could plainly diſtinguiſh the *Vitreous* and *Cryſtalline* Humours, yea, the *Ligamentum Ciliare*, and the atramentaceous *Mucus*. The *Pupil* I could manifeſtly diſcern to be round, and the *Cornea* copped, or conical: The Eye is at a great Diſtance from the Brain, the Optick Nerve very ſlender and long, reaching from the Eye through the intermediate Fleſh, and ſo paſſeth to the Brain, along with the Pair of Nerves reaching to the Noſe, which are much the largeſt that are in all the Animal. Theſe Creatures, I imagine, that uncouth Animal is wholly ſubterraneous, its Lodging, its Food, its Exerciſes, nay, even all its' Paſtimes and Pleaſures, are in thoſe ſubterraneous Receſſes and Paſſages, which its own Induſtry hath made for itſelf; ſo it is an admirable Proviſion made in the Size of the Eye of that little Creature, to anſwer all its Occaſions, and at the ſame Time to prevent Inconveniences. For as a little Light will ſuffice an Animal living always under Ground; ſo the ſmalleſt Eye will abundantly ſupply that Occaſion. And as a large protuberant Eye, like that of other Animals, would much annoy this Creature in its principal Buſineſs, of digging for its Food and Paſſage; ſo it is endowed with a very ſmall one, commodiouſly ſeated in the Head, and well fenced and guarded againſt the Annoyances of the Earth.

5. Another Thing remarkable in this noble Part of Animals, is, its *Numbers*; no leſs than two (*n*) in any Inſtance that I know of; and in ſome Animals more, as I have already hinted (*o*).

Now this is an admirable Proviſion; firſt, for the Convenience of taking in the larger Angle, or Space: And in the next Place, the Animal is by this Proviſion, in ſome Meaſure, prepared for the

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gine, have the Faculty of withdrawing their Eyes, if not quite into the Head (*as Snails*), yet more or leſs within the Hair, as they have more or leſs Occaſion to uſe or guard their Eyes.

Galen ſaith, *Moles* have Eyes, the *Cryſtaline* and *Vitreous* Humours, encompaſſed with *Tunicks*. *De Uſu Part*. lib. xiv. cap. 6. So accurate an Anatomiſt was he for his Time.

(*n*) *Pliny* tells us of a Sort of *Heron* with but one Eye, but it was only by Hear-ſay. *Inter Aves Ardeolarum genere, quos Leucos vocant, altero oculo carere tradunt*. Nat. Hiſt. lib. xi. cap. 37. So the King of the *Nigræ* that hath but one Eye, and that in his Forehead, *lib*. vi. *cap*. 30. Which Fables I take Notice of more for the Reader's Diverſion, than any Truth in them.

(*o*) *Supra*, Note (*i*).

Misfortune of the Loſs of one of theſe noble, and neceſſary Organs of its Body.

But then beſides all this, there is another Thing conſiderable in this multiplicate Number of the Eye; and that is, that the Object ſeen is not multiplied as well as the Organ, and appears but one, though ſeen with two or more Eyes (*p*). A manifeſt

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(*p*) The moſt celebrated Anatomiſts differ greatly about the Reaſon why we ſee not double with two Eyes. This *Galen*, and others after him, generally thought to be from a Coalition or Decuſſation of the Optick Nerves, behind the *Os Sphenoides*. But whether they decuſſate, coaleſce, or only touch one another, they do not well agree. The *Bartholines* expreſly aſſert, they are united, *Non per ſimplicem contactum vel interjectionem in hominem, ſed totalem ſubſtantiæ confuſionem*. Anat. lib. iii. cap. 2. And whereas *Veſalius*, and ſome others, had found ſome inſtances of their being diſunited; they ſay, *Sed in pleriſque ordinariè confunditur interior ſubſtantia, ut accuratâ diſquiſitione deprehendi.*

But our learned Dr. *Gibſon* (*Anat.* lib. iii. cap. 10.) ſaith, they *are united by the closeſt Conjunction, but not Confuſion, of their Fibres.*

But others think the Reaſon is not from any Coaleſcence, Contact, or croſſing of the Optic Nerves, but from a Sympathy between them. Thus Monſieur *Cartes* is of Opinion, That the *Fibrillæ*, conſtituting the medullary Part of thoſe Nerves, being ſpread in the *Retina* of each Eye, have each of them correſponding Parts in the Brain; ſo that when any of thoſe *Fibrillæ* are ſtruck by any Part of an Image, the correſponding Parts of the Brain are thereby affected, and the Soul thereby informed, &c. But ſee more hereafter, under Note (*oo*), from *Cartes* himſelf.

Somewhat like this is the Notion of our judicious Dr. *Briggs*, who thinks the Optick Nerves of each Eye conſiſt of *Homologous Fibres*, having their Riſe in the *Thalamus Nervorum Opticorum*, and thence continued to both the *Retinæ*, which are made of them: And farther, that thoſe *Fibrillæ* have the ſame Paralleliſm, Tenſion, &c. in both eyes, and conſequently, when an Image is painted on the ſame correſponding, ſympathizing Parts of each *Retina*, the ſame Effects are produced, the ſame Notice or Information is carried to the *Thalamus*, and ſo imparted to the Soul, or judging Faculty. That there is ſuch an 'Ομοιοπάθεια between the *Retinæ*, &c. he makes very probable, from the enſuing of double Viſion upon

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nifeſt Sign of the infinite Skill of the Contriver of this ſo noble a Part, and of the exquiſite Art he employed in the Formation thereof. But the Deſign and Skill of the infinite Workman will beſt be ſet forth by,

6. Surveying the *Parts* and *Mechaniſm* of this admirable Organ, the Eye. And here indeed we cannot but ſtand amazed, when we view its admirable Fabrick, and conſider the prodigious Exactneſs, and the exquiſite Skill employed in every Part miniſtring to this noble and neceſſary Senſe. To paſs by its Arteries and Veins, and ſuch other Parts common to the reſt of the Body, let us caſt our Eye on its *Muſcles.* Theſe we ſhall find exactly and neatly placed for every Motion of the Eye. Let us view its *Tunicks*, and theſe we ſhall find ſo admirably ſeated, ſo well adapted, and of ſo firm a Texture, as to fit every Place, to anſwer every Occaſion, and to be Proof againſt all common In-

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the Interruption of the Parallelism of the Eyes: as when one Eye is depreſſed with the Finger, or their Symphony interrupted by Diſeaſe, Drunkenneſs, *&c.* And laſtly, That ſimple Viſion is not made in the former Way, *viz.* by a Decuſſation or Conjunction of the Optick Nerves, he proves, becauſe thoſe Nerves are but in few Subjects decuſſated, and in none conjoined otherwiſe than by a bare Contact, which is particularly manifeſt in Fiſhes; and in ſome Inſtances it hath been found, that they have been ſeparated without any double Viſion enſuing thereupon. *Vide Brig. Ophthalmogr.* cap. xi. & v. and *Nov. Viſ. Theor. paſſim.*

What the Opinion of our juſtly eminent Sir *Iſaac Newton* is, may be ſeen in his *Opticks*, Qu. 15. *Are not the Species of Objects ſeen with both Eyes, united where the Optick Nerves meet before they come into the Brain, the Fibres on the right Side of both Nerves uniting there,* &c. *For the Optick Nerves of ſuch Animals as look the ſame Way with both Eyes, (as of Men, Dogs, Sheep, Oxen,* &c.) *meet before they come into the Brain; but the Optic Nerves of ſuch Animals as do not look the ſame Way with both Eyes, (as of Fiſhes, and of the Cameleon) do not meet, if I am rightly informed.* Newt. Opt. Qu. 15.

conveniences and Annoyances. Let us examine its three *Humours*, and theſe we ſhall find all of exquiſite Clearneſs and Tranſparency, for an eaſy Admiſſion of the Rays; well placed for the refracting of them, and formed (particularly the *Cryſtalline Humour*) by the niceſt Laws of Opticks, to collect the wandring Rays into a Point. And to name no more, let us look into its darkned Cell, where thoſe curious Humours lie, and into which the Glories of the Heavens and the Earth are brought, and exquiſitely pictured; and this Cell we ſhall find, without, well prepared by Means of its Texture, Aperture, and Colour, to fence off all the uſeleſs or noxious Rays; and within, as well coated with a dark Tegument, that it may not reflect, diſſipate, or any way confuſe or diſturb the beneficial Rays (*q*).

But to deſcend to Particulars, although it would be a great Demonſtration of the Glory of God, yet it would take up too much Time, and hath been in ſome Meaſure done by others that have written of God's Works. Paſſing over therefore what they have obſerved, I ſhall under each principal Part take a tranſient Notice of ſome Things they have omitted, or but ſlightly ſpoken of.

And my firſt Remark ſhall be concerning the *Muſcles* of the Eye and their Equilibration. Nothing can be more manifeſtly an Act of Contrivance and Deſign, than the *Muſcles* of the Eye, admirably adapted to move it any, and every way; upwards, downwards, to this Side or that, or how-

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(*q*) *Nigra eſt* [Uvea] *ut radios (ab Oculi fundo ad anteriorem ejus partem reflexos) obumbret; nè hi (ut ait clar. Carteſius) ad Oculi fundum retorti ibidem confuſam viſionem efficerent. Alia forſan ratio hujus nigredinis ſtatuatur, quòd radii in viſione ſuperflui, qui ab objectis lateralibus proveniunt hoc ritu abſorbeantur. Ita enim è loco obſcuro interdiu objecta optimè intuemur, qui radii tunc temporis circumfuſo lumine non diluuntur.* Briggs's Ophthal. chap. iii. ſect. 5.

ſoever we pleaſe, or there is Occaſion for, ſo as to always keep that Paralleliſm of the Eye, which is neceſſary to true Viſion. For the Performance of which Service, the Form, the Poſition, and the due Strength of each Muſcle is admirable. And here I might inſtance the peculiar and artificial Structure of the *Trochlearis*, and the Augmentation of its Power by the *Trochlea (r)*; the Magnitude and Strength of the *Attollent Muſcle*, ſomewhat exceeding that of its Antagoniſt; the peculiar Muſcle, called the *Seventh*, or *Suſpenſory Muſcle (s)*, given to Brutes, by reaſon of the prone Poſture of their Bodies, and frequent Occaſions to hang down their

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(r) Admirandum Dei artificium ex diverſorum animalium comparatione indies evadit manifeſtiùs. Mirantur omnes Trochlearem in oculis Hominum & Quadrupedum, & quidem jure: ſed admirationem omnem ſuperat, quòd ſine Trochleâ oculum movens in Avibus novum genus Trochleæ longè artificioſius Nictitandi Membranæ dederit. Blaſ. Anat. Animal. p. ii. cap. 4. *ex Stenon.*

[Muſculum Trochlearem] *per intermedium trochleam traductum, nunquam intueor, quin admirabundus mecum.* Ὁ Θεὸς, *exclamem,* οὐ μόνον ἀεὶ γεωμετρεῖ, ἀλλὰ ϗ ἀεὶ μηχανᾶται. *I. C. Sturmii Exercit. Acad. 9. de Viſ. Org. & Rat. cap.* iii. *ſect. 4. p.* 446.

(s) Obſervare eſt quod Quadrupedes, qui oculos in terram pronos, ac pendulos gerunt, Muſculum peculiarem habent, quo Oculi globus ſuſpenditur — Hoc Muſculo, Bos, Equus, Ovis, Lepus, Porcus, &c. præditi ſunt: hoc etiam Canis inſtruitur, ſed alio modo conformatum habet. Willis de An. Brut. p. i. cap. 15.

Of this opinion alſo was *Bartholine, Anat.* lib. iii. cap. 8. and divers other eminent Anatomiſts.

But Dr. *Briggs* is of Opinion that the *Adnata,* and the other Muſcles, ſufficiently anſwer all thoſe Ends aſcribed to that Muſcle by former Anatomiſts, and thinks *Probabiliùs itaque eſſe hunc Muſculum nervi Optici actionem (per vices confirmare, nè à prono Brutorum inceſſu & copioſo affluxu humorum debilitetur.* Ophthal. cap. ii. ſect. 2.

The *Muſculus Suſpenſorius* being in the *Porpeſs,* as well as Brutes, Dr. *Tyſon* thinks the Uſe of it is not to ſuſpend the Bulk of the Eye, but rather, by its equal Contraction of the *Sclerotis,* to render the Ball of the Eye more or leſs Spherical, and ſo fitter for Viſion. *Tyſon's Anat. of the Porpeſs,* p. 39.

Heads: And I might ſpeak alſo of the peculiar Origin and Inſertion of the *lower Oblique Muſcle (t)*, which is very notable, and many other Things relating to theſe Parts; but it would be tedious to deſcend too much to thoſe admirable Particulars. And therefore to cloſe up theſe Remarks, all I ſhall farther take Notice of, ſhall be only the exquiſite Equilibration of all theſe *Oppoſite* and *Antagoniſt Muſcles*, affected partly by the Equality of the Strength; which is the Caſe of the *Adducent* and *Abducent Muſcles*; partly by their peculiar Origin, or the Addition of the *Trochlea*, which is the Caſe of the *Oblique Muſcles (u)*; and partly by the Natural Poſture of the Body, and the Eye, which is the Caſe of the *Attollent* and *Depriment Muſcles*. By this ſo curious and exact a Libration, not only unſeemly Contortions, and incommodious Vagations of the

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(t) Muſculus obliquus inferior oritur à peculiari quodam foramine in latère Obitæ ocularis facto, (contra quàm in cæteris, &c.) quo fit ut ex unâ parte à Muſculo trochleari, ex alterâ verò ab hujus Muſculi commodiſſimâ poſitione, Oculus in æquilibrio quodam conſtitutus, irretorto obtutu verſus objecta feratur, nec plus juſto accedat verſus internum externumve canthum; quæ quidem Libratio omnino nulla fuiſſet, abſque hujus Muſculi peculiari originatione (cujus ratio omnes hucuſque Anatomicos latuit.) And ſo this curious Anatomiſt goes on to ſhew farther the ſtupendous Artifice of the great Creator in this Poſition of the *Oblique Muſcles*. *Briggs*'s *Nova Viſ. Theor.* p. 11. *meo libro.*

(u) Beſides theſe particular Motions which the Eye receives from the *Oblique Muſcles*, and I may add its Libration alſo in ſome Meaſure, ſome Anatomiſts aſcribe another no leſs conſiderable uſe to them; namely, to lengthen and ſhorten the Eye (by ſqueezing and compreſſing it) to make it correſpond to the Diſtances of all Objects, according as they are nigh or far off. Thus the ingenious Dr. *Keil: The Aqueous Humour being the thinneſt and moſt liquid, eaſily changeth its Figure, when either the* Ligamentum Ciliare *contracts, or both the* Oblique Muſcles *ſqueeze the Middle of the Ball of the Eye, to render it Oblong when Objects are too near us.* Keil's Anat. chap. iv. ſect. 4. See *Note (y)*.

Eye are prevented, but alſo it is able with great Readineſs and Exactneſs to apply itſelf to every Object.

As to the *Tunicks* of the Eye, many Things might be taken notice of, the prodigious Fineneſs of the *Arachnoides*; the acute Senſe of the *Retina*, the delicate Tranſparency of the *Cornea* (*w*), and the firm and ſtrong Texture of that and the *Sclerotica* too; and each of them, in theſe and every other reſpect, in the moſt accurate Manner adapted to the Place in which it is, and the Buſineſs it is there to perform. But for a Sample, I ſhall only take Notice of that Part of the *Uvea* which makes the *Pupil*. It hath been obſerved by others, particularly by our Honourable Founder (*x*), That as we are forced to uſe various Apertures to our Optick Glaſſes, ſo Nature hath made a far more complete Proviſion in the Eyes of Animals, to ſhut out too much, and to admit ſufficient Light, by the Dilatation and Contraction of the Pupil (*y*). But it deſerveth our eſpecial Remark, that theſe Pupils are

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(*w*) *Quis verò opifex præter Naturam, quâ nibil poteſt eſſe callidius, tantam ſolertiam perſequi potuiſſet in Senſibus? quæ primum Oculos membranis tenuiſſimis veſtivit, & ſepiit; quas primam perlucidas fecit, ut per eas cerni poſſet: firmas autem, ut continerentur.* Cic, de Nat. Deor. lib. ii. cap. 57.

(*x*) *Boyle* of *Final Cauſes.*

(*y*) It is eaſy to be obſerved, that the *Pupil* openeth in dark Places; as alſo when we look at far diſtant Objects, but contracts by an Increaſe of Light, and when the Objects are nigh. This Motion of the *Pupil*, ſome ſay, is effected by the circular and ſtrait Fibres of the *Uvea*, and ſome attribute it to the *Ligamentum Ciliare*. Yet I have no great doubt but that they both concur in that Action, and that the *Ligamentum Ciliare* doth, at the ſame Time the Pupil opens or ſhuts, dilate or compreſs the *Cryſtalline*, and bring it nigher unto, or carry it farther off the *Retina*. For the Structure of the *Ligamentum Ciliare*, and its two Sorts of Fibres, drawn with the Help of a Microſcope, I ſhall refer to Mr. *Cowper's Anat. T.* 11.

in divers Animals of divers Forms, according to their peculiar Occaſions. In ſome (particularly in Man) it is round; that being the moſt proper Figure for the Poſition of our Eyes, and the Uſe we make of them both by Day and Night. In ſome other Animals it is of a longiſh Form; in ſome tranſverſe *(z)*, with its Aperture large, which is an admirable Proviſion for ſuch Creatures to ſee the better laterally, and thereby avoid Inconveniences, as well as help them to gather their Food on the Ground, both by Day and Night. In other Animals the Fiſſure of the Pupil is erect *(aa)*, and alſo capable of opening wide, and ſhutting up cloſe. The latter of which ſerves to exclude the brighter Light of the Day, and the former to take in the more faint Rays of the Night, thereby enabling thoſe Nocturnal Animals (in whom generally this erect Form of the Pupil is) to catch their Prey with the greater Facility in the Dark *(bb)*, to ſee upwards

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(z) In Bove, Caprâ, Equo, Ove, & quibuſdam aliis elliptica eſt [Pupilla] *ut eo magis in hiſce forſan animalibus, quæ prono inceſſu victum in agris quæritant, radios laterales ad mala & incommoda utrinque devitanda admittat.* Briggs's Ophthal. cap. vii. ſect. 6.

Homini erecto, aliiſque, &c. caput erigere, & quaquaverſus circumſpicere ſolitis, plurima ſimul objecta, tum ſuprà tum infrà, tum è latere utroque — viſu excipiuntur; quapropter Oculi Pupilla rotunda eſſe debet. — Attamen bovi, &c. caput ferè ſemper pronum — gerentibus, tantùmque coràm, & paulo à latere obverſantur, intuitu opus eſt; quapropter Pupilla — oblonga eſt, &c. Willis de Anim. Brut. p. i. cap. 15.

(aa) Thus *Cats* (their Pupils being erect, and the ſhutting of their Eye-lids tranſverſe thereunto) can ſo cloſe their Pupil, as to admit of, as it were, only one ſingle ray of Light; and by throwing all open, they can take in all the fainteſt Rays. Which is an incomparable Proviſion for theſe Animals, that have Occaſion to watch and way-lay their Prey both by Day and Night.

(bb) There is, beſides this large opening of the Pupil, in ſome nocturnal Animals, another admirable Proviſion, enabling them

upwards and downwards, to climb, *&c.* Thus much for the *Tunicks*.

The next Thing I ſhall take Notice of, will relate to the *Humours* of the Eye, and that only concerning the Mechaniſm of the *Cryſtalline Humour*; not its incomparable Tranſparency; nor its exact lenticular Form; nor its curious araneous Membrane *(cc)*, that conſtringeth and dilateth it, and ſo

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them to catch their Prey in the dark; and that is a Radiation of the Eyes: Of which Dr. *Willis* thus; *Hujus uſus eſt Oculi Pupillam, quaſi jubare inſito, illuminare, ut res noctu, & in tenebris poſitas conſpicere valeat: quare in Fele plurimùm illuſtris eſt: at Homini, Avibus & Piſcibus deeſt.* This Illumination he ſpeaks of, is from the *Tapetum*, in the Bottom of the Eye, or the ſhining of the *Retina*, round the Optic Nerve.

Beſides which, he ſaith, the *Iris* hath a Faculty alſo, in ſome, of darting out Rays of Light, ſo as to enable them to ſee in the dark: Of which he tells this Story; *Novi quendam cerebro calidiori præditum, qui poſt uberiorem vini generoſi potum in nocte atratâ ſive tenebris profundis, literas diſtinctè legere potuit. Cujus ratio videtur eſſe, quòd ſpiritus animales velut accenſi, adeoque ab hâc Iride irradiantes, jubare inſito Medium illuminabant.* Willis ibid.

Such another Thing, *Pliny* tells us, was reported of *Tiberius Cæſar*: *Ferunt Tib. Cæſ. nec alii genitorum mortalium, fuiſſe naturam, ut expergefactus noctu pauliſper, haud alio modo quam luce clarâ, contueretur omnia.* Nat. Hiſt. lib. xi. cap. 37.

So Dr. *Briggs*: *Virum ſanè calidæ indolis novi in Comitatu Bedfordienſi degentem, qui oculis felineis — donatus eſt: adeò ut epiſtolam — mire admodum in loco obſcuro (ubi eadem mihi vix apparuit) perlegit. Hujus verò Oculi (niſi quod Pupillas inſigniores obtinuere) ab aliorum formatione neutiquam diſcrepabant.* Ophthal. cap. v. ſect. 12.

(cc) The *Tunica Aranea* is taken Notice of by *Friar Bacon*, who calls it, *Tela Aranea*, and ſaith, *in hâc continetur — glaciale vel Cryſtallinum.* Rog. Bacon's *Perſpect. Diſtinct.* ii. *cap.* 3. The wrinkling of this, and the *Cornea*, (as the Skin is of old Perſons) he thinks is the cauſe of the Obſcurity of the Sight in ſuch Perſons. *Bacon*, ibid. par. ii. cap. 2. But this *Tunick* ſome deny, and others allow of: Dr. *A. M.* of *Trinity College, Dublin*, (in his *Relat. of Anat. Obſ.* in the Eyes of Animals, in a Letter to Mr. *Boyle*, *Ann.* 1684, annexed to his *Anat. Account of the Elephant burnt in* Dublin, p. 57.) affirms

ſo varieth its *Focus* (if any ſuch Variation there be, as ſome affirm with great Probability,) nor laſtly,

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the *Tunica Aranea*, and ſaith, *I have often ſeen it before it was expoſed to the Air one Minute, notwithſtanding what Dr.* Briggs *ſaith to the contrary, &c.* But Dr. *Briggs*'s Opinion is, *Humor Cryſtallinus, niſi aeri diutiùs expoſitus, vel leniter coctus (inſtar lactis) cuticulam non acquirit: quæ verò impropriè, Tunica Aranea dicitur, cùm ſi tantùm adventitia, ùt in Oculo Bovis recens exacto appareat.* Briggs's Ophthal. cap. 3.

The *Cryſtalline Humour* being of a double Subſtance, outwardly like a Jelly, towards the Centre as conſiſtent as hard Suet, upon Occaſion whereof its Figure may be varied; which Variation may be made by the *Ligamentum Ciliare*; Dr. *Grew* doth, upon theſe Accounts, not doubt to aſcribe to the *Ligamentum Ciliare*, a Power of making the *Cryſtalline* more Convex, as well as of moving it to or from the *Retina*. See *Grew's Coſmolog. Sacr.* lib. i. cap. 4. Now it is certain, by the Laws of Optics, that ſomewhat of this is abſolutely neceſſary to diſtinct Viſion, inaſmuch as the Rays proceeding from nigh Objects do more diverge, and thoſe from diſtant Objects leſs: Which requires either that the *Cryſtalline Humour* ſhould be made more convex, or more flat; or elſe an Elongation, or ſhortening of the Eye, or of the Diſtance between the *Cryſtalline Humour* and the *Retina*.

But although Dr. *Briggs* (ſo good a Judge) denies the *Tunica Cryſtallina*, contrary to the Opinion of moſt former Anatomiſts; yet there is great Reaſon to conclude he was in a Miſtake, in my Opinion, from the Obſervations of the *French Anatomiſts*, of the *Cryſtalline* of the Eye, of the *Gemp* or *Chamois*, who ſay, The *Membrana Arachnoïdes was very thick and hard, ſo that it was eaſily ſeparated from the Cryſtallinus.* P. 145.

The ſame Anatomiſts alſo favour the Surmiſe of Dr. *Grew*. This [Contraction of the Fibres of the *Ligamentum Ciliare* on one Side, and Dilatation on the other] *would make us think, that theſe Fibres of the* Ligamentum Ciliare *are capable of Contraction and voluntary Dilatation, like that of the Fibres of the Muſcles; and that this Action may augment or diminiſh the Convexity of the* Cryſtallinus, *according as the Need which the Diſtance of the Objects may make it to have on the Eye, to ſee more clearly and diſtinctly.* Anat. Deſcript. of a *Bear*, p. 49.

Since my penning the foregoing Notes, having, as critically as I could, diſſected many Eyes of Birds, Beaſts, and Fiſhes, I manifeſtly found the *Membrana Arachnoïdes*, and will undertake to ſhew it any one, with great Eaſe and Certainty. It is ly, its admirable Approach to or from the *Retina*, by the help of the *Ciliar Ligament* (*dd*), according as Objects

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Indeed ſo tranſparent, as not to be ſeen diſtinct from the *Cryſtalline*. But if the *Cornea* and *Uvea* be taken off before, or the *vitreous Humour* behind it, and the Outſide of the *Cryſtalline* be gently cut, the *Arachnoïdes* may be ſeen to open, and the *Cryſtalline* will eaſily leap out, and part from the *Ligamentum Ciliare*; which otherwiſe it would not do: For it is by the *Arachnoïdes* braced to the *Ligamentum Ciliare*. This Membrane or Tunick, in the Ox, is ſo ſubſtantial and ſtrong, though thin, that it yields to, or ſinks under the ſharpeſt Lancet, and requires (for ſo thin and weak a Membrane in Appearance) a ſtrong Preſſure to pierce it.

(*dd*) As Birds and Fiſhes are in divers Things conformable, ſo in ſome ſort they are in their Eye; to enable it to correſpond to all the Convergences and Divergences of the Rays, which the Variations of each of the Mediums may produce. For this Service the *Tunica Choroeides* (in Fiſhes) hath a muſculous Subſtance at the Bottom of it, lying round the Optick Nerve, at a ſmall Diſtance from it; by which Means I imagine they are able to contract and dilate the *Choroeides*, and thereby to lengthen and ſhorten the Eye: For the helping in which Service, I imagine it is that the *Choroeides* and *Sclerotica* are in a great meaſure parted, that the *Choroeides* may have the greater Liberty of acting upon the Humours within.

But in Birds, I have myſelf found, that although the *Choroeides* be parted from the *Sclerotica*, yet the *Choroeides* hath no Muſcle, but inſtead thereof, a curious pectinated Work, ſeated on the Optic Nerve, repreſented in *Fig.* 2. in which *c, a, e, b, d,* repreſents the *Choroeides* and *Sclerotica*; *a, b,* the Part of the *Optick Nerve* that is within the Eye; *v, v, v,* the *vitreous Humour*; *a, f, g, b.* the *Pecten*; *h, i,* the *Cryſtalline*. For the Reception of this *Pecten*, the *Optick Nerve* comes farther within the Eye, than in other Creatures. The Structure of this *Pecten* is very like that of the *Ligamentum Ciliare*, and in the Eye of a *Magpye*, and ſome others, I could perceive it to be muſculous towards the Bottom. This *Pecten* is ſo firmly fixed unto, or embodied in the *vitreous Humour*, that the *vitreous Humour* hangs firmly to it, and is not ſo eaſily parted from it. By which Means all the Motions of the *Pecten* are eaſily communicated to the *vitreous Humour*, and indeed to all contained in the *Choroeides*. And foraſmuch as the *Cryſtalline* is connected to the *vitreous Humour*, therefore alſo the Alterations in the *vitreous Humour* affect alſo the *Cryſtalline*; and the

Objects are far off or near, becauſe theſe Things are what are uſually taken notice of; but that which I ſhall obſerve is, the prodigious Art and Finery of its conſtituent Parts, it being, according to ſome late nice Microſcopical Obſervations *(ee)*, compoſed

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Cryſtalline is hereby brought nearer unto, or farther from the *Retina*, as Occaſion is.

Beſides all which Obſervables in the *Choroeides*, and inner Eye, I have alſo found this farther remarkable in the *Sclerotica*, and outer-part of the Eye of Birds, *viz*. That the fore-part of the *Sclerotica* is horny and hard, the middle-part thin and flexible, and *Braces* intervene between the fore and hind-part, running between the *Choroeides* and *Sclerotica*; by which Means the *Cornea*, and back-part of the Eye, are brought to the ſame Conformity that the reſt of the Eye hath.

The great End and Deſign of this ſingular and curious *Apparatus* in the Eyes, both of Birds and Fiſhes, I take to be, 1. To enable thoſe Creatures to ſee at all Diſtances, far off, or nigh: which (eſpecially in the Waters) requireth a different Conformation of the Eye. In Birds alſo, this is of great Uſe, to enable them to ſee their Food at their Bill's End, or to reach the utmoſt Diſtances their high Flights enable them to view; as to ſee over great Tracts of Sea or Land, whither they have Occaſion to fly; or to ſee their Food or Prey, even ſmall Fiſhes in the Waters, and Birds, Worms, &c. on the Earth, when they ſit upon Trees, high Rocks, or are hovering high in the Air. 2. To enable thoſe Animals to adapt their Eye to all the various Refractions of their *Medium*. Even the Air itſelf varies the Refractions, according as it is rarer or denſer, more or leſs compreſſed; as is manifeſt from the learned and ingenious Mr. *Lowthorp*'s Experiment in *Philoſ. Tranſact.* Nº 257. and ſome other Experiments ſince of the before-commended Mr. *Hawkſbee*, both in natural, rarefied, and compreſſed Air; in each of which, the Refractions conſtantly varied in exact Proportion to the Rarity or Denſity of the Air, *Vide Hawkſbee's Exp.* p. 175, &c.

Beſides this Conformity in general, between the Eyes of Birds and Fiſhes, *Du Hamel* tells us of a ſingular Conformity in the *Cormorant*'s Eye, and that is, that the *Cryſtalline* is globous, as in Fiſhes, to enable it to ſee and purſue its Prey under Water: Which *J. Faber*, in Mr. *Willoughby*, ſaith, they do *with wonderful Swiftneſs, and for a long Time.* Will. Ornithol. p. 329.

(ee) The *Cryſtalline Humour*, when dried, doth manifeſtly enough

poſed of divers thin Scales, and theſe made up of one ſingle minuteſt Thread or Fibre, wound round and round, ſo as not to croſs one another in any one Place, and yet to meet, ſome in two, and ſome in more different Centres; a Web not to be woven, an *Optick Lens*, not to be wrought by any Art leſs than infinite Wiſdom.

Laſtly, To conclude the Parts of this admirable Organ, I ſhall only make one Remark more, and that is about its *Nerves*. And here among others, the admirable Make of the *Optick Nerves* might deſerve to be taken Notice of in the firſt Place, their *Medullary* Part *(ff)* terminating in the Brain itſelf, the Teguments propagated from the *Meninges*, and terminating in the Coats of the Eye, and their commodious Inſertions into the Ball of the Eye, in ſome directly oppoſite to the Pupil of the Eye, in others

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enough appear to be made up of many very thin ſpherical *Laminæ*, or Scales, lying upon one another. Mr. *Lewenhoek* reckons there may be two thouſand of them in one *Cryſtalline*, from the outermoſt to the Centre. Every one of theſe Scales, he ſaith, he hath diſcovered to be made up of one ſingle Fibre, or fineſt Thread, wound, in a moſt ſtupendous Manner, this Way, and that Way, ſo as to run ſeveral Courſes, and meet in as many Centres, and yet not to interfere, or croſs one another, in any one Place. In *Oxen*, *Sheep*, *Hogs*, *Dogs*, and *Cats*, the Thread ſpreads into three ſeveral Courſes, and makes as many Centres: in *Whales* five; but in *Hares* and *Rabbets* only two. In the whole Surface of an *Ox*'s *Cryſtalline*, he reckons there are more than twelve thouſand Fibres juxtapoſited. For the right and clear underſtanding of the Manner of which admirable Piece of Mechaniſm, I ſhall refer to his Cuts and Deſcriptions in *Philoſ. Tranſ.* N° 165, and 193. The Truth hereof I have heard ſome ingenious Men queſtion; but it is what I myſelf have ſeen, and can ſhew to any Body, with the Help of a good Microſcope.

(ff) S. *Malpighi* obſerved the Middle of the *Optick Nerve* of the *Sword-Fiſh*, to be nothing elſe but a large Membrane, folded according to its Length in many Doubles, almoſt like a Fan, and inveſted by the *Dura Mater*; whereas in Land-Animals it is a Bundle of Fibres. *Vide Philoſ. Tranſ.* N° 27.

obliquely towards one Side *(gg)*. But moſt of theſe Things have been treated of, and the Convenience hereof ſet forth, by others that have written of GOD's Works. I ſhall therefore take Notice only of one wiſe Proviſion the Creator hath made about the Motion of the Eye, by uniting it into one of the *Third Pair* of Nerves, called the *Motory Nerves (hh)*, each of which ſending its Branches into each Muſcle of each Eye, would cauſe a Diſtortion in the Eyes; but being united into one, near their Inſertion into the Brain, do thereby cauſe both Eyes to have the ſame Motion; ſo that when one Eye is moved this Way and that Way, to this and that Object, the other Eye is turned the ſame Way alſo.

Thus from this tranſient and ſlight View (I may call it) of the Parts of the Eye, it appears what an admirable Artiſt was the Contriver thereof. And now in the

Seventh and laſt Place, let us conſider what Proviſion this admirable Artiſt hath made for the *Guard* and *Security* of this ſo well form'd Organ *(ii)*. And here

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(gg) Certiſſimum eſt, quòd in omnibus Oculis humanis (quos ſaltem mihi diſſecare contigit) Nervus opticus Pupillæ à diametro opponitur, &c. Briggs's Ophthal. cap. iii. ſect. 15. Ita *Willis de Anim. de Brut.* p. i. c. 15.

Nervi Optici in nobis, item in Cane, Fele (& in cæteris forſan animalibus calidis) ad fundum Oculi *delati Pupillæ regioni proſpiciunt, dum interim in aliis Quadrupedibus, uti etiam in Piſcibus & Volucribus, obliquè ſemper Tunicæ Scelerotidi inſeruntur. Unde,* Willis, ibid. cap. vii. ſect. 11.

(hh) This Pair is united at its Riſe; whence is commonly drawn a Reaſon why one Eye being moved towards an Object, the other is directed alſo to the ſame. Gibſon's Anat. Book III. Chap. xi. So *Bartholine Anat.* lib. iii. cap. 2.

(ii) Among all the other Security the Eye hath, we may reckon the Reparation of the *Aqueous Humour*; by which Means the Eye when wounded, and that in all Appearance very dangerouſly too, doth often recover its Sight: Of which *Lern. Vorzaſcha* gives divers Examples, ancient and modern. One

here we ſhall find the Guard equivalent to the Uſe and Excellency of the Part. The whole Organ fortified and fenced with ſtrong, compact Bones, lodged in a ſtrong, well made Socket, and the Eye itſelf guarded with a nice made Cover *(kk)*. Its Humours,

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One is from *Galen*, of a Boy ſo wounded, that the *Cornea* fell, and became flaccid, but yet recovered his Sight. Other ſuch like Inſtances alſo he gives from *Realdus*, *Columbus*, *Rhodius*, and *Tulpius*; and one that he cured himſelf, in theſe Words; *Ego in Nobiliſſimi viri filiolâ ſimilem caſum obſervavi: hæc dum levibus de cauſis cum fratre altercaret, iſte iracundiâ percitus cultellum Scriptorium apprehendit, & ſororis oculo vulnus infligit, inde humor aqueus effluxit. Vocatus præſentem Chirurgum juſſi ſequens collyrium anodynum & exſiccans tepidè ſæpiùs admovere.* ℞ *aq. Plantag.* ℥iv, *Roſar. Sanicul. Euphraſ.* ana *Trochiſc. alb. Rhaſ. cum Opio* ℈ij *Tutiæ pp.* ℈j. *Croci orient.* ℈ß. M. *Hoc Collyrium inflammationem compeſcuit, vulnus ſiccavit & ſanavit. Hinc poſt aliquot menſes Humor aqueus ſuccrevit. Nam viſus, ſed debilior, cum ſummo parentum gaudio redivit.* B. Verzaſchæ Obſerv. Medicæ, Obſ. 14.

Another Cure of this Kind was experimented by Dr. *Daniel Major*, upon a Gooſe, *Ann.* 1670. the *Aqueous Humour* of both whoſe Eyes they let out, ſo that the Eyes fell; and the Gooſe became quite blind: But, without the Uſe of any Medicine, in about two Days Time, Nature repaired the watery Humour again, the Eyes returned to their former Turgeſcency, and the Gooſe was in a Week after produced Seeing before twenty-eight or thirty Spectators. *Ephem. Germ. T.* 1. *Add. ad Obſ.* 117.

From the ſame Cauſe, I doubt not, it was that the Eye of a Gentleman's Daughter, and thoſe of a Cock, when wounded, ſo that the *Cornea* ſunk, were reſtored by a *Lithuanian* Chemiſt, that paſſed for a Conjurer, by the Uſe of a Liquor found, in *May*, in the Veſiculæ of *Elm*. Of which See Mr. *Ray*'s *Catal. Cantab.* in *Ulmus*, from *Henr. ab Heers*.

(kk) Palpebræ, quæ ſunt tegumenta Oculorum, molliſſim. tactu, nè læderent aciem, aptiſſimæ factæ, & ad claudendas Pupillas, nè quid incideret, & ad aperiendas; idque providit, ut identidem fieri poſſet cum maxima celeritate. Munitæque ſunt Palpebræ tanquàm vallo pilorum: quibus & apertis Oculis, ſi quid incideret, repelleretur, & ſomno conniventibus, cùm Oculis ad cernendum non egerimus, ut qui, tanquàm involuti, quieſcerent. Latent prætereà utiliter, & excelſis undique partibus ſepiuntur. Primùm enim ſuperiora Superciliis obducta ſudorem à capite, & fronte defluentem repellunt.

mours, and its inward Tunicks, are indeed tender, proportionate to their tender, curious Uſes; but the

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repellunt. Genæ deinde ab inferiore parte tuantur ſubjectæ, leviterque eminentes: Cic. de Nat. Deor. lib. ii. cap. 57.

Tully, in the Perſon of a *Stoick*, having ſo well accounted for the Uſe of the *Eye-lids*, I ſhall for a farther Manifeſtation of the Creator's Contrivance and Structure of them, take Notice of two or three Things; 1. They conſiſt of a thin and flexible, but ſtrong Skin, by which Means they the better wipe, clean, and guard the *Cornea*. 2. Their Edges are fortified with a ſoft *Cartilage*, by which Means they are not only enabled the better to do their Office, but alſo to cloſe and ſhut the better. 3. Out of theſe Cartilages grow a Palliſade of ſtiff Hairs, of great Uſe to warn the Eye of the Invaſion of Danger, to keep off Motes, and to ſhut out too exceſſive Light, *&c.* and at the ſame Time to admit of (through their Intervals) a ſufficient Paſſage for Objects to approach the Eye. And it is remarkable, that theſe Hairs grow but to a certain, commodious Length, and need no cutting, as many other Hairs of the Body do: Alſo, That their Points ſtand out of the Way, and in the Upper-lid bend upwards, as they do downwards in the Lower-lid, whereby they are well adapted to their Uſe. From which laſt Obſervables, we may learn how critical and nice the great Author of Nature hath been, in even the leaſt and moſt trivial Conveniences belonging to Animal Bodies; for which Reaſon I have added it to *Tully*'s Remarks. And more might have been added too, as particularly concerning the curious Structure and Lodgment of the *Right Muſcle*, which opens the Eye-lids, and the *Orbicularis*, or *Circular* one, that ſhuts them; the nice *Apparatus* of Glands that keep the Eye moiſt, and ſerve for *Tears*: together with the Reaſon why Man alone, who is a Social Animal, doth exhibit his Social Affections by ſuch outward Tokens as *Tears*; and *Nerves* alſo, and other Organs acting in this Miniſtry. I might alſo ſpeak of the Paſſages for diſcharging the ſuperfluous Moiſture of the Eyes through the Noſtrils, and much more of the like Kind. But it would take up too much Room in theſe Notes; and therefore it ſhall ſuffice to give only ſuch Hints as may create a Suſpicion of a noble Œconomy and Contrivance in this (I had almoſt ſaid) leaſt conſiderable Part of the Eye. But for Particulars I ſhall refer to the Anatomiſts; and for ſome of theſe Things, particularly to Dr. *Willis*'s *Cereb. Anat.* and *de. Anim. Brut.* and Mr. *Cowper's* Elegant Cuts in the 11th *Tab.* of his *Anatomy*.

To the Eye-lids we may add another Guard afforded the Eyes of moſt Quadrupeds, Birds, and Fiſhes, by the *Nictitating* the Coats without, are context and callous, firm and ſtrong. And in ſome Animals, particularly Birds *(ll)*, ſome Part of thoſe Tunicles have the Nature and Hardneſs of Bone or Horn.

But for Creatures, whoſe Eyes, like the reſt of their Body, are tender, and without the Guard of Bones; there Nature hath provided for this neceſſary and tender Senſe, a wonderful kind of Guard, by endowing the Creature with a Faculty of withdrawing its Eyes into its Head *(mm)*, and lodging them in the ſame Safety with the Body..

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ing Membrane, which Dr. *Willis* gives this Account of: *Plurimis* [Animalibus] *quibus Muſculus ſuſpenſorius adeſt* [which Limitation he needed not to have added) *etiam alter Membranoſus conceditur, qui juxta interiorem oculi canthum ſitus, quando elevatur, Oculi globum ferè totum obtegit. Hujus uſus eſſe videtur, ut tùm Beſtiæ inter gramina, &c. capita ſua propter victum capeſſendum demergunt, hic Muſculus Oculi Pupillam, nè à ſtipularum incurſu feriatur, oculit munitque.* De Anim. Brut. p. i. cap. 15.

This Membrane Man hath not, he having little Occaſion to thruſt his Head into ſuch Places of Annoyance, as Beaſts, and other Animals; or if he hath, he can defend his Eyes with his Hands. But Birds (who frequent Trees and Buſhes) and Quadrupeds (Hedges and long Graſs), and who have no Part ready, like the Hand, to fence off Annoyances; theſe, I ſay, have this incomparable Proviſion made for the Safety of their Eyes. And for Fiſhes, they are deſtitute of Eye-lids, becauſe in the Waters there is no Occaſion for a Defenſative againſt Duſt and Motes, offenſive to the Eyes of Land-Animals, not to moiſten and wipe the Eyes, as the Eye-lids do; ſo the *Nictitating Membrane* is an abundant Proviſion for all their Occaſions, without the Addition of the Eye-Lids.

And now, if we reflect, are theſe the Works of any Thing but a wiſe and indulgent Agent?

(ll) Although the Hardneſs and Firmneſs of the *Adnata*, or *Sclerotica* in Birds, is a good Guard to their Eyes, yet I do not think it is made thus, ſo much for a Defence, as to miniſter to the lengthening and ſhortening the Eye, mentioned before in *Note (cc)*.

(mm) Cochleis oculorum vicem Cornicula bina prætentu implent. Plin. Nat. Hiſt. lib. xi. cap. 37. See more of the Eyes of *Snails*

Thus have I ſurveyed this firſt Senſe of Animals; I may ſay in a curſory, not accurate, ſtrict Manner; conſidering the prodigious Workmanſhip thereof; but ſo, as abundantly to demonſtrate it to be the Contrivance, the Work of no leſs a Being than the infinite, wiſe, potent and indulgent Creator *(nn)*. For none leſs could compoſe ſo admirable an Organ, ſo adapt all its Parts, ſo adjuſt it to all Occaſions, ſo nicely provide for every Uſe, and for every Emergency: In a Word, none leſs than God could, I ſay, thus contrive, order, and provide an Organ, as magnificent and curious as the Senſe is uſeful; a Senſe without which, as all the Animal World would be in perpetual Darkneſs, ſo it would labour under perpetual Inconveniencies, be expoſed to perpetual Harms, and ſuffer perpetual Wants and Diſtreſſes. But now by this admirable Senſe, the great God, who hath placed us in this World, hath as well provided for our comfortable Reſidence in it; enabled us to ſee and chuſe wholeſome, yea, delicate Food; to provide ourſelves uſeful, yea, gaudy Cloathing and commodious Places of Habitation and Retreat. We can now diſpatch our Affairs with Alacrity and Pleaſure, go here and there as our Occaſion calls us. We can, if Need be, ranſack the whole Globe, penetrate into the Bowels of the Earth, deſcend to the Bottom of the Deep, travel to the fartheſt Regions of this World, to acquire Wealth, to encreaſe

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Snails before in *Note (k)*; and in *Note (l)* I ſaid that I ſuſpected *Moles* alſo might thruſt out, or withdraw their Eyes more or leſs within the Hair or Skin.

(nn) The diligent *Sturmius* was fully perſuaded there could not be any ſpeculative Atheiſm in any that ſhould well ſurvey the Eye. *Nobis*, ſaith he, *fuit perſuaſſimum, Atheiſmum, quem vocant ſpeculativum, h. e. obfirmatam de Deitate in Univerſo nullâ perſuaſionem, habere locum aut inveniri non poſſe in eo homine, qui vel unius corporis organici, & ſpeciatim Oculi fabricam attento animo aſpexerit.* Sturm. Exerc. Acad. 9. de Viſ. Organ. & Rat. in Epilogo.

our Knowledge, or even only to pleaſe our Eye and Fancy. We can now look about us, diſcern and ſhun the Precipices and Dangers which every where encloſe us, and would deſtroy us. And thoſe glorious Objects which fill the Heavens and the Earth, thoſe admirable Works of God which every where ſurround us, and which would be as nothing to us, without being ſeen, do by Means of this noble Senſe preſent their Glories to us *(oo)*, and fill us with Ad-

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(oo) The glorious Landſkips, and other Objects that preſent themſelves to the Eye, are manifeſtly painted on the *Retina*, and that not erect, but inverted, as the Laws of Opticks require; and is manifeſt to the Eye from Monſieur *Cartes*'s Experiment, of laying bare the vitreous Humour on the Back-part of the Eye, and clapping over it a Bit of white Paper, or the Skin of an Egg; and then placing the Fore-part of the Eye to the Hole of a Window of a darkened Room. By which means we have a pretty Landſkip of the Objects abroad, invertedly painted on the Paper, on the Back of the Eye. But now the Queſtion is, How in this Caſe the Eye comes to ſee the Object erect? Monſieur *Cartes*'s Anſwer is, *Notitia illius ex nullâ imagine pendet, nec ex ullâ actione ab objectis veniente, ſed ex ſolo ſitu exiguarum partium cerebri, è quibus Nervi expullulant. — E. g. cogitandum in Oculo — ſitum capillamenti nervi optici — reſpondere & alium quendam partis cerebri — qui facit ut Anima ſingula loca cognoſcat, quæ jacent in rectâ, aut quaſi rectâ lineâ; ut ita mirari non debeamus corpora in naturali ſitu videri, quamvis imago in oculo delineata contrarium habeat.* Dioptr. cap. 6. But our moſt ingenious Mr. *Molyneux* anſwereth thus: *The Eye is only the Organ or Inſtrument, it is the Soul that ſees by Means of the Eye. To enquire then how the Soul perceives the Object erect, by an inverted Image, is to enquire into the Soul's Faculties. — But erect and inverted are only Terms of Relation to up and down; or farther from, or nigher to the Centre of the Earth, in Parts of the ſame Thing. — But the Eye, or viſive Faculty, takes no Notice of the internal Poſture of its own Parts, but uſeth them as an Inſtrument only, contrived by Nature for the Exerciſe of ſuch a Faculty. — Let us imagine, that the Eye* (on its lower Part) *receives an Impulſe* [by a Ray from the upper Part of the Object] *muſt not the viſive Faculty be neceſſarily directed hereby to conſider this Stroke as coming from the Top rather than the Bottom* [of the Oject] *and conſequently be directed to conclude it the Repreſentation of the Top? Hereof we may be ſatisfied by ſup-*

miration and Pleaſure. But I need not expatiate on the Uſefulneſs and Praiſes of this Senſe, which we receive the Benefit of every Moment, and the Want, or any Defect of which, we lament among our greateſt Misfortunes.

Leaving then this Senſe, I ſhall proceed to the other four, but more briefly treat of them, by Reaſon we have ſo ample a Sample of the Divine Art in the laſt, and may preſume that the ſame is exerted in all as well as one. For a Demonſtration of which, let us in the next Place carry our Scrutiny to the Senſe of *Hearing*.

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poſing a Man ſtanding on his Head. For here, though the upper Parts of Objects are painted on the upper Parts of the Eye, yet the Objects are judged to be Erect. What is ſaid of Erect and Reverſe, may be underſtood of Siniſter and Dexter. Molyneux's Dioptr. Nov. Part I. Prop. 28.

CHAP. III.

Of the Senſe of Hearing.

CONCERNING the Senſe of *Hearing*, I ſhall take Notice of two Things; the Organ, the *Ear*; and its Object, *Sound.*

I. For the Organ, the *Ear*; I ſhall paſs by its convenient Number of being double, which (as in the laſt Senſe) ſerves for the commodious Hearing every Way round us; as alſo a wiſe Proviſion for the utter Loſs or Injury (*a*) of one of the Ears. But I ſhall

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(*a*) I preſume it will not be ungrateful to take Notice here of the admirable, as well as uſeful Sagacity of ſome deaf Perſons that have learned to ſupply their Want of *Hearing* by underſtanding what is ſaid by the Motion of the Lips. My very ingenious Friend Mr. *Waller*, R. S. Secr. gives this Account: *There live now, and have from their Birth, in our Town, a Man and his Siſter, each about fifty Years old, neither of which have the leaſt Senſe of* Hearing *—yet both of theſe know, by the Motion of the Lips only, whatever is ſaid to them, and will anſwer pertinently to the Queſtion propoſed to them. — The Mother told me they could hear very well, and ſpeak when they were Children, but both loſt that Senſe afterwards, which makes them retain their Speech; though that, to Perſons not uſed to them, is a little uncouth and odd, but intelligible enough.* Philoſ. Tranſ. N° 312.

Such another Inſtance is that of Mr. *Goddy*, Miniſter of St. *Gervais* in *Geneva*, his Daughter. *She is now about ſixteen Years old. Her Nurſe had an extraordinary Thickneſs of* Hearing; *at a Year old, the Child ſpake all thoſe little Words that Children begin to ſpeak at that Age.—At two Years old, they perceived ſhe had loſt her* Hearing, *and was ſo Deaf, that ever ſince, though ſhe hears great Noiſes, yet ſhe hears nothing that one can ſpeak to her.—But by obſerving the Motions of the Mouth and* *Lips*

I ſhall a little inſiſt upon its Situation, and its admirable Fabrick and Parts.

1. It is ſituated in the moſt convenient Part of the Body, (like as I ſaid the Eye is) in a Part near the common Senſory in the Brain, to give the more ſpeedy Information; in a Part where it can be beſt guarded, and where it is moſt free from Annoyances and Harms itſelf, and where it gives the leaſt Annoyance and Hindrance to the Exerciſes of any other Part; in a Part appropriated to the peculiar Uſe of the principal Senſes, in the moſt lofty, eminent Part of the Body, where it can perceive the moſt Objects, and receive the greateſt Information: And laſtly, in a Part in the Neighbourhood of its Siſter Senſe the Eye, with whom it hath peculiar and admirable Communication by its Nerves, as I intend to ſhew in its proper Place. In reſpect then of its Situation and Place in the Body, this Senſe is well deſigned and contrived, and may ſo far be accounted the Work of ſome admirable Artiſt. But,

2. If we ſurvey its Fabrick and Parts, it will appear to be an admirable Piece of the Divine Wiſdom, Art, and Power. For the Manifeſtation of which, let us diſtinctly ſurvey the outward and the inward Part of its curious Organ.

Lips of others, ſhe hath acquired ſo many Words, that out of theſe ſhe hath formed a Sort of Jargon, in which ſhe can hold Converſation whole Days with thoſe that can ſpeak her own Language. I could underſtand ſome of her Words, but could not comprehend a Period, for it ſeemed to be but a confuſed Noiſe. She knows nothing that is ſaid to her, unleſs ſhe ſeeth the Motion of their Mouths that ſpeak to her; ſo that in the Night, when it is neceſſary to ſpeak to her, they muſt light a Candle. Only one Thing appeared the ſtrangeſt Part of the whole Narration: She hath a Siſter, with whom ſhe hath practiſed her Language more than with any other; and in the Night, by laying her Hand on her Siſter's Mouth, ſhe can perceive by that what ſhe ſaith, and ſo can diſcourſe with her in the Night. Biſhop *Burnet*'s Let. iv. p. 248.

1. For the *outward Ear*: If we obſerve its Structure in all Kinds of Animals, it muſt needs be acknowledged to be admirably Artificial, it being ſo nicely prepared, and adjuſted to the peculiar Occaſions of each reſpective Animal. In Man (*b*), it is of a Form proper for the erect Poſture of his Body. In Birds, of a Form proper for Flight; not protuberant, becauſe that would obſtruct their Progreſs, but cloſe and covered, to afford the eaſier Paſſage through the Air. In Quadrupeds, its Form is agreeable to the Poſture, and ſlower Motion of their Bodies; and in theſe too, various according to their various Occaſions. In ſome large, erect, and open, to hear the leaſt Approaches of Dangers (*c*); in others covered,

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(*b*) I cannot but admire, that our moſt eminent modern Anatomiſts ſhould not agree, whether there be any Muſcles in the outward Ear of Man or not. Dr. *Keil* ſaith there are two; Dr. *Drake* the ſame Number; and Dr. *Gibſon* makes them to be four. So alſo doth Monſieur *Dionis*, and ſo did the ancient Anatomiſts: But Dr. *Schelhammer* expreſly denies there are any, and ſaith, *Seduxit autem reliquos Brutorum Anatome, in quorum pleriſque tales Muſculi plures inveniuntur; putârunt autem fortaſſis ignominioſum Homini, ſi non & his inſtructus eſſet, & minùs inde perfectum animal fore.* Schel. de Auditu, p. i. cap. 1. ſect. 7. But *Valſalva*, who wrote very lately, and is very accurate in his Survey of the Ear, ſaith, *Muſculi auriculæ poſteriores quandoque quatuor, quandoque duo; ſed ut plurimùm tres adnotantur; & quando ſolùm duo ſe manifeſtant, tunc unus ex illis duplicato tendine versùs Concham deferri ſolet. Horum muſculorum in numero varietatem non ſolùm in diverſis; verum etiam in eodem ſubjecto quandoque vidi.—Ex quibus differentiis ſubortæ ſunt Auctorum diſcrepantiæ in horum Muſculorum numero, & poſitu:—quod non eveniſſet, ſi pluries in diverſis Corporibus iidem Muſculi quæſiti eſſent.* Ant. Mar. Valſalva *de Aur. Human.* cap. i. ſect. 6. But Dr. *Drake* thinks ſome of *Valſalva*'s Muſcles the Product of Fancy. Mr. *Cowper* makes them to be three, one *Attollent*, and two *Retrahent Muſcles*. See *Anat.* Tab. 12.

(*c*) *Inter cæteræ* [animalia aurita] *maximè admirabilis eſt auris leporinæ fabrica, quòd cum timidiſſimum animal ſit, & prorſus inerme, natura id tum auditu acutiſſimo, tanquam hoſtium exploratore*

covered, to keep out noxious Bodies. In the Subterraneous Quadrupeds, who are forced to mine and dig for their Food and Habitation, as a protuberant Ear, like that of other Quadrupeds, would obſtruct their Labours, and be apt to be torn and injured; ſo they have the contrary (*d*), their Ears ſhort,

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ploratore ad perſentienda pericula, tum pedibus ceu armis ad currendum aptis muniſſe videtur. A. Kircher's *Phonurg.* lib. i. ſect. 7. Technaſ. 2.

(*d*) *Moles* have no protuberant Ear, but only a round Hole between the Neck and Shoulder; which Situation of it, together with the thick, ſhort Fur that covers it, is a ſufficient Defenſative againſt external Annoyances. The *Meatus Auditorius* is long, round, and cartilaginous, reaching to the under Part of the Skull. Round the Inſide runs a little Ridge, reſembling two Threads of a Skrew; at the Bottom whereof is a pretty Inlet leading to the Drum, made, on one Side, with the aforeſaid cochleous Ridge, and on the other, with a ſmall Cartilage. I obſerved there was *Cerumen* in the *Meatus*.

As to the *inner Ear*, it is ſomewhat ſingular, and different from that of the other Quadrupeds, and much more from Birds; although I have met with ſome Authors that make it agreeing with that of Birds. There are three ſmall Bones only (all hollow) by which the *Drum* (to uſe the old Appellation) or the *Membrana Tympani* (as others call it) acteth upon the *Auditory Nerve*. The firſt is the *Malleus*, which hath two Proceſſes nearly of equal Length; the longer of which is braced to the *Membrana Tympani*; the ſhorter to the Side of the *Drum* or *Os Petroſum*, the back Part of it reſembles the Head and Stalk of a ſmall *Muſhroom*, ſuch as are pickled. On the Back of the *Malleus* lies the next ſmall Bone, which may be called the *Incus*, long, and without any Proceſs, having ſomewhat the Form of the ſhort Scoop wherewith Watermen throw the Water out of their Wherries. To the End of this the third and laſt ſmall Bone is tacked by a very tender Brace. This little Bone bears the Office of the *Stapes*, but is only forked without any Baſe. One of theſe Forks is at one *Feneſtra*, or *Foramen*, the other at another; in which *Feneſtræ* I apprehend the Forks are tacked to the Auditory Nerve. Theſe *Feneſtræ* (equivalent to the *Feneſtra Ovalis*, and *Rotunda* in others) are the Inlets into the *Cochlea* and *Canales Semicirculares*, in which the *Auditory Nerve* lieth. The *Semicircular Canales* lie at a Diſtance ſhort, lodged deep and backward in their Head, and paſſing to the under Part thereof, and all ſufficiently fenced and guarded. And as for Inſects, Reptiles, and the Inhabitants of the Waters, if they enjoy this Senſe, (as there is great Reaſon to think they do), it may probably be lodged commodiouſly under the ſame Security and Guard, as the Smelling, or ſome other Senſe is.

And moreover, as the Form of this Organ is various in various Animals, ſo in each of them its Structure is very curious and obſervable, being in all admirably contrived to collect the wandering, circumambient Impreſſions and Undulations of Sound, and to convey them to the Senſory within. If I ſhould run over the ſeveral *Genera* of Animals, we might find a notable Proſpect of the Handy-work of God *(e)*, even in this ſo inconſiderable a Part of Ani-

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Diſtance from the *Drum*, and are not lodged (as in other Animals) in a ſtrong, thick Body of Bone, but are thruſt out, within the Skull, making an *Antrum*, with an handſome *Arch* leading into it, into which a Part of the Brain enters.

One Leg of the *Malleus* being faſtened to the *Membrana Tympani*, and the *Incus* to the back of the *Malleus*, and the Top of that to the Top of the *Stapes*, and the Forks or Branches of the *Stapes* to the *Auditory Nerve*, I obſerved that whenever I moved the Membrane, all the little Bones were at the ſame Time moved, and conſequently the *Auditory Nerve* thereby affected alſo.

I hope the Reader will excuſe me for being ſo particular in this Organ only of the *Mole*, a deſpiſed Creature, but as notable an Example of *God*'s Work, as its Life is different from that of other Quadrupeds; for which Reaſon it partly is that I have enlarged on this Part differing from that of others, and which nobody that I know of, hath taken much Notice of, and which is not diſcoverable without great Patience and Application; and partly becauſe by comparing theſe Obſervations with *Book* VII. *Chap.* ii. *Note (d)*, we may judge how the Senſe of Hearing is performed.

(e) *Among many Varieties, both in the inner and outer Ear, thoſe which appear in the Paſſage into the Rock Bone, are remarkable. For in an* Owl, *that perches on a Tree or Beam, and*

Animals. But I ſhall only carry my Survey to that of Man. And here the firſt Thing that offereth itſelf to our View, is the *Helix*, with its tortuous Cavities, made to ſtop, and collect the ſonorous Undulations, to give them a gentle Circulation and Refraction, and ſo convey them to the *Concha*, or larger and more capacious round Cell at the Entrance of the Ear. And to bridle the Evagation of the Sound, when arrived ſo far, but withal not to make a Confuſion thereof, by any diſagreeable Repercuſſions, we may take Notice of a very curious Proviſion in thoſe little Protuberances, called the *Tragus*, and *Antitragus* of the outward Ear, of a commodious Form and Texture (*f*), and conveniently lodged for this Uſe. The great Convenience and Benefit of this Form and Contrivance of the outward Ear, is ſufficiently manifeſt by the Want thereof, which cauſeth a *Confuſion in the Hearing, with a certain Murmur, or Swooing, like the Fall of Waters* (*g*).

Another

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hearkens after the Prey beneath her, it is produced farther out above than it is below, for the better Reception of the leaſt Sound. But in a Fox, *that ſcouteth underneath the Prey at Rooſt, it is, for the ſame Reaſon, produced farther out below. In a* Pole-Cat, *which hearkens ſtrait forward, it is produced behind, for the taking of a forward Sound. Whereas in a* Hare, *which is very quick of Hearing, and thinks of nothing but being purſued, it is ſupplied with a bony Tube, which, as a natural Otocouſtick, is ſo directed backward, as to receive the ſmalleſt and moſt diſtant Sound that comes behind her.* Grew's Coſmolog. Sacr. lib. i. cap. v. ſect. 6.

(*f*) The Texture of the *Tragus* and *Antitragus*, is ſofter than that of the *Helix*, which ſerveth gently to blunt, not forcibly repel, the Sound in the *Concha*.

(*g*) Dr. *Gibſon*'s Anatomy, book III. chap. 22.

Thoſe whoſe Ears are cut off, have but a confuſed Way of Hearing, and are obliged either to form a Cavity round the Ear with their own Hands, or elſe to make uſe of a Horn, and apply the End of it to the inner Cavity of the Ear, in order to receive the agitated

Another wiſe Proviſion of the Creator, is in the Subſtance of the outward Ear, which is cartilaginous, the fitteſt for this Place. For (as an ingenious Anatomiſt (*b*) obſerves,) "If it had been "Bone, it would have been troubleſome, and might "by many Accidents, have been broken off: If "Fleſh, it would have been ſubject to Contuſion." But indeed a worſe Conſequence than this would have enſued ſuch a Softneſs as that of Fleſh, and that is, it would neither have remained expanded, neither would it ſo kindly receive and circulate the Sounds, but abſorb, retard, or blunt their Progreſs into the inward Organ. But being hard, and curiouſly ſmooth and tortuous, Sounds find an eaſy Paſſage, with a regular Volutation and Refraction: As in a well-built Arch, Grotto, or muſical Inſtrument, which magnify and meliorate Sounds; and ſome of which convey even a Whiſper to a large Diſtance (*i*): But from the outward, let us carry our Survey,

2. To

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agitated Air. It is likewiſe obſerved, that thoſe whoſe Ears jut out, hear better than flat-eared Perſons. Monſieur *Dionis*'s Anat. Demonſt. 8.

(*b*) *Gibſon* ibid.

(*i*) It would nauſeate the Reader to reckon up the Places famed for the Conveyance of Whiſpers, ſuch as the Priſon of *Dionyſius* at *Syracuſe*, which is ſaid to increaſe a Whiſper to a Noiſe; the clapping one's Hands to the Sound of a Cannon, *&c.* Nor the *Aquæducts* of *Claudius*, which carry a Voice ſixteen Miles; and many others, both ancient and modern, If the Reader hath a mind to be entertained in this Way, he may find enough in *Kircher's Phonurgia.* But it may not be irkſome to mention one or two of our own in *England*. Among which, one of the moſt famed is the *Whiſpering Place* in *Glouceſter Cathedral*, which is no other than a Gallery above the Eaſt End of the Choir, leading from one Side thereof to the other. It conſiſteth (if I miſtake not) of five Angles, and ſix Sides, the middlemoſt of which is a naked, uncovered Window, looking into a Chapel behind it. I gueſs the two Whiſperers ſtand at about twenty-five Yards Diſtance from one another.

But

2. To this inward Part of this admirable Organ. And here we find the moſt curious and artful Proviſion for every Emergency and Occaſion. The *Auditory Paſſage*, in the firſt Place, curiouſly tunnelled, and artfully turned, to give Sounds an eaſy Paſſage, as well as a gentle Circulation and Refraction; but withal, ſo as to prevent their too furious ruſhing in, and aſſaulting the more tender Parts within.

And foraſmuch as it is neceſſary that this Paſſage ſhould be always open to be upon the Watch (k); therefore, to prevent the Invaſion of noxious Inſects, or other Animals, (who are apt to make their Retreat in every little Hole,) Nature hath ſecured this Paſſage (l), with a bitter nauſeous

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But the *Dome* of St. *Paul's*, *London*, is a more conſiderable *Whiſpering Place*, where the ticking of a Watch (when no Noiſe is in the Streets) may be heard from Side to Side; yea, a Whiſper may be ſent all round the *Dome*. And not only in the Gallery below, but above, upon the Scaffold, I tried, and found that a Whiſper would be carried over one's Head, round the Top of the Arch, notwithſtanding there is a large Opening in the Middle of it, into the upper Part of the *Dome*.

(k) *Auditus autem ſemper patet: ejus enim ſenſu etiam dormientes egemus: A quo cùm ſonus eſt acceptus, etiam è ſomno excitamur. Flexuoſum iter habet, nè quid intrare poſſit, ſi ſimplex, & directum pateret: proviſum etiam, ut ſiqua minima beſtiola conaretur irrumpere, in ſordibus aurium, tanquam in viſco, inhæreſceret.* Cic. de Nat. Deor. lib. ii. cap. 57.

It deſerves a particular Remark here, that in Infants in the Womb, and newly born, the *Meatus Auditorius* is ſhut up very cloſely, partly by the Conſtriction of the Paſſage, and partly by a glutinous Subſtance, whereby the *Tympanum* is guarded againſt the Water in the *Secundine*, and againſt the Injuries of the Air as ſoon as the Infant is born.

(l) It is remarkable, that in moſt, if not all Animals, whoſe Ears are tunnelled, or where the *Meatus Auditorius* is long enough to afford Harbour to *Ear-wigs*, or other Inſects; that, I ſay, in the Ears of ſuch, *Ear-wax* is conſtantly to be found. But in Birds, whoſe Ears are covered with Feathers, and where the *Tympanum* lies but a little Way within the Skull, no *Ear-wax* is found, becauſe none is neceſſary to the Ear ſo well guarded, and ſo little tunnelled.

Excrement *(m)*, afforded from the Glands *(n)* appointed for that Purpoſe.

From hence let us approach the moſt inward Parts, in which we ſhall ſee Strokes of the moſt exquiſite Art. To paſs over the *innate Air*, that moſt Authors talk of *(o)*, (becauſe there is no ſuch) the

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(m) The *Ear-wax* was thought, by the old Anatomiſts, to be an Excrement of the Brain: *Humor bilioſus à cerebro expugnatus*, the *Bartholines* ſay of it, *lib.* iii. *cap.* 9. But, as *Schelhammer* well obſerves, *Nil abſurdius, quàm cerebri excrementum hoc ſtatuere. Nam & ratio nulla ſuadet, ut in cerebro fieri excrementum tale credamus: — neque viæ patent per quas ab eo ſeclusum in meatum auditorium poſſit inde penetrare.* As to its Taſte, *Caſſerius* gives Inſtances of its being ſweet in ſome Creatures. But *Schelhammer* ſays, *Ego verò ſemper, cum amaritie aliquid dulcedinis in illo deprehendi.* Vide Schel. de Audit. *p.* i. *cap.* 2. *ſect.* 10. But I could never diſtinguiſh any Sweetneſs in it; but think it inſipid, mixed with a Bitterneſs.

(n) Cerumina amara Arteriolis exudantia. Willis de Anim. Brut. par. i. cap. 14. *In the Skin — are little Glands, which furniſh a yellow and bitter Humour.* Monſieur *Dionis*'s Dem. 18. An handſome Cut of thoſe *Glandulæ Ceruminoſæ* is in Dr. *Drake*, from *Valſalva*.

Pliny attributes a great Virtue to the *Ear-wax*: *Morſus hominis inter aſperrimos numeratur: medentur ſordes ex auribus: ac ne quis miretur, etiam Scorpionum ictibus Serpentiumque ſtatim impoſitæ.* Plin. Nat. Hiſt. lib. xxviii. cap. 4. And that it hath an healing Quality, and may be accounted a good Balſam, I myſelf have experienced.

(o) That there is ſuch a Thing as the *innate Air*, (talked of much by moſt Authors on this Subject) *Schelhammer* very juſtly, I think, denies; by Reaſon there is a Paſſage into the inner Ear from the Throat, through which the *innate Air* may paſs out, and the outward Air enter in. *Vide Par. Alt.* p. ii. cap. 1. ſect. 10. When by ſtopping our Breath, and ſtraining, we force the external Air into the Ear, it may be heard ruſhing in; and if much be forced in, it may be felt alſo to beat againſt the *Tympanum*. When the Paſſage to the Throat is by any Means ſtopped, as by a Cold in the Head, *&c.* the Hearing thereby becomes dull and blunt; by Reaſon the Communication between the outward and inward Air is obſtructed: But when by ſtrong Swallowing, or ſuch like Motion of the Throat, the Paſſage is opened, we perceive it by a ſudden Smack

the Paſſage to the Palate *(p)*, and their Uſes, with divers other curious Things that might be named; let us ſtop a little at the Part containing the reſt, namely, the Bone *(q)*. The particular Texture and Hardneſs of which, above other Bones of the Body, is very remarkable: whereby it ſerves not only as a ſubſtantial Guard to the Senſory, but alſo to oppoſe the Impulſes of the ætherial Matter, that there may be no Loſs nor Confuſion in the Sound; but that it may be convey'd regularly, and intirely to the auditory Nerves.

Smack or Crack, and we immediately hear very clearly; the Load of feculent Air being at that Time diſcharged from the inner Ear.

It is a wiſe Proviſion, that the Paſſage for the Air into the Ear, is from the Throat; *Ut non ſtatim quivis aer externus irrumpere queat* (as *Schelhammer* ſaith, *Par. ult. cap.* 4. *ſect.* 8.) *ſed nonnihil immutatus, ac temperatus, calore ex medio ventre exſpirante; imo fortaſſis non facile alius, niſi ex pulmonibus.*

(p) Valſalva hath given us a more accurate Deſcription of the *Tuba Euſtachiana*, or *Paſſage* to the *Palate*, than any other Author; to whom I therefore refer, *De Aur. Human.* cap. ii. ſect. 16, *&c.*

The chief Uſe hereof, he thinks, is to give way to the inner Air, upon every Motion of the *Membrana Tympani*, the *Malleus*, *Incus*, and *Stapes*. This Paſſage if it be ſhut up, Deafneſs enſues: Of which he gives two Inſtances: One a Gentleman, who loſt his Hearing by a Polypus in the Noſe reaching to the *Uvula*; the other a Yeoman, labouring with an Ulcer above the left Side of the *Uvula*; which when he ſtopped with a Tent dipped in Medicine, he loſt his Hearing in the left Ear, and recovered it, as ſoon as the Tent was out. *Ibid.* cap. v. ſect. 10.

(q) Os [petroſum] *ex quo interiores* [Labyrinthi] *cavitatum parietes conflati ſunt, album, duriſſimum, necnon maxime compactum. Id autem à Naturâ ita comparatum eſſe videtur, ut materia ætherea Sonorum objectorum impreſſionibus onuſta, dum prædictis impingitur Parietibus, nihil aut ſaltem fere nihil motûs ſui amittat, atque adeò illum qualem ab Objectis ſonoris accepit, talem communicet ſpiritui animali contento intra expanſiones rami mollioris Nervorum auris.* Dr. *Raym. Vieuſſens* of *Montpellier*, in Phil. Tranſ. Nº 258.

The next Part I ſhall take Notice of may be that fine Membrane, called the *Tympanum*, or *Membrana Tympani* (r), with its inner Membrane (s); together with the four little appendent Bones (t),
and

(r) The *Tympanum* of the Ear, or, as *Valſalva* and the Moderns, the *Membrana Tympani*, was taken Notice of as early as *Hippocrates*'s Time. In Birds, it is ſtrained towards the outward Parts; in other Animals, towards the Brain, or inner Parts. Monſieur *Dionis* ſaith, *It is not equally faſtened to the whole Circumference of the bony Circle, in which it is inchaſed; for on the upper Side it hath a free diſengaged Part, by which ſome can give vent to the Smoak in their Mouth.* Demonſtr. 8. That *there* is ſome Paſſage, I doubt not; but I queſtion whether Monſieur *Dionis* ever ſaw the diſengaged Part he mentions. I have myſelf carefully ſearched divers Subjects, and do not remember to have ſeen any ſuch Paſſage: and I perceive it eſcaped the diligent *Schelhammer*'s Eye. *Valſalva* alſo, by injecting in through the *Tuba Euſtachiana*, could not force any Liquor into the *Meatus Auditorius*; but yet he imagines he found the Paſſage out in another Place of the Drum, in ſome morbid, and one ſound Head. *Valſalv. de Aur. Hum.* cap. ii. ſect. 8. Mr. *Cowper* alſo affirms, there is a Paſſage by the upper Part of the Membrane. *Anat. Ap.* Fig. 8.

(s) Dr. *Vieuſſens*, before named, diſcovered a Membrane, *tenuiſſimæ raræque admodùm texturæ intra cavitatem Tympani*; as he deſcribes it. Whoſe Uſe, he ſaith, is, 1. *Occludens Labyrinthi januam impedit nè naturalis puriſſimus ac ſubtiliſſimus Aer intra cavitates — communicationem — habeat cum aere craſſo.* 2. *Labyrinthi baſin calefacit,* &c. *ubi ſupra.* Probably this double Membrane may be ſuch, or after the ſame Manner as it is in the *Tympanum* of Birds: Of which ſee my Obſervations in *Book* II. *Chap.* ii. *Note (d).*

(t) The four little Bones being treated of by all that have concerned themſelves about this Senſe of Hearing, ſince their Diſcovery, I ſhall take Notice of only two Things concerning them. 1. The Diſcovery of them is owing wholly to the Diligence and Sagacity of the latter Ages; of which *Schelhammer* gives this Account from *Fallopius*: *Hæc Oſſicula antiquis Anatomicis — ignota fuere; primuſque qui in lucem produxit* [Malleum & Incum] *fuit Jac. Carpenſis; primus quoque procul omni dubio Anatomicæ artis, quam Veſalius poſteà perfecit, reſtaurator. Tertium* [Stapedem] *invenit ac promulgavit primus Joh. Phil. ab Ingraſſia, Siculus, Philoſophus, ac Medicus doctiſſimus. Quartum, Thomâ Bartholin. teſte, viro longè celeberrimo, Fran.*
Sylvio

and the three inner Muſcles to move them, and adjuſt the whole *Compages* to the ſeveral Purpoſes of Hearing, to hear all Manner of Sounds, loud or languid, harſh or grateful *(u)*.

From

Sylvio debetur Schel. *ubi ſupra*, cap. iii. ſect. 9. 2. Their Difference in Animals: In *Man*, and *Quadrupeds*, they are four, curiouſly inarticulated with one another; with an external and internal Muſcle to draw, or work them, in extending or relaxing the *Drum*; but in *Fowls* the Caſe is very different: *His unum Oſſiculum ſolùm largita eſt Natura, quod mobilis, quæ in Tympanum videtur terminari.* Id. ibid. ſect. 8. *Columellam fortè appellaveris; teres enim eſt & ſubtiliſſimum, baſi innitens latiori, rotundæ. Huic annexa eſt cartilago valde. In the Ears of all the Fowl that I could examine, I never found any more than one Bone and a Cartilage, making a Joint with it, that was eaſily moveable. The Cartilage had generally an Epiphyſe, or two, one on each Side. — The Bone was very hard and ſmall, having at the End of it a broad Plate, of the ſame Subſtance, very thin, upon which it reſted, as on its Baſis.* Dr. *Al. Moulen*, in Phil. Tranſ. Nº 100.

These are the moſt material Things I find obſerved by others, concerning the Ears of Fowls, and ſome of them hardly, I believe, obſerved before. To which I ſhall ſubjoin ſome other Things I have myſelf diſcovered, that I preſume eſcaped the Eyes of thoſe moſt curious and inquiſitive Anatomiſts. Of which the laſt cited *Book* VII. *Chap.* ii. *Note (d)*.

(u) *Videtur quod Tympanum Auditionis inſtrumentum præliminare, & quaſi præparatorium fuerit, quod Soni impreſſionem, ſive ſpecies ſenſibiles primo ſuſcipiens, eas in debitâ proportione, & aptâ conformitate, versùs Senſorium, quod adhuc interius ſitum eſt, dirigat: ſimili officio fungitur reſpectu Auditûs, ac tunicæ Oculi Pupillam conſtituentes, reſpectu Viſûs; utræque Membranæ Species ſenſibiles refringunt & quaſi emolliunt, eaſque Senſorio non niſi proportionatas tradunt, cui nudo ſi adveniant, teneriorem ejus craſin facilè lædant, aut obruant. Reverâ Tympanum non audit, ſed meliori tutiorique Auditioni confert. Si hæc pars deſtruatur, Senſio adhuc aliquandiu, redi licèt, modo, peragi poſſit; quippe experimento olim in Cane facto, &c. — Janitoris officio ut Tympanum rectè defungi poſſit, expanſum ejus pro datâ occaſione ſtringi, aut relaxari debet, veluti nimirùm Oculi Pupilla — Quapropter huic Auris Tympano, non ſecus ac bellico, machinæ ſive tæniæ quædam opponuntur, quæ ſuperficiem ejus modò tenſiorem, modò laxiorem reddant: hoc enim efficiunt tria Oſſicula, cum Muſculo, &c.* Willis de Anim. Brut. cap. 14.

For

From this Region of the *Tympanum*, I might
paſs

For this Opinion of Dr. *Willis*, Dr. *Schelhammer* is very ſevere upon him, deriding the Refractions he ſpeaks of; and therefore ſeriouſly proves that they are the Humours, not Tunicks of the Eye, that refract the Rays of Light; and then jeeringly demandeth, whether the ſonorous Rays are refracted by paſſing through a different Medium? Whether the Convexity or Concavity of the Drum collects thoſe Rays into a focal Point, or ſcatters them, &c. And then ſaith, *Ob has rationes à clariſſ. Viri, ac de re Medicâ præclarè meriti, ſententiâ non poſſumus non eſſe alienores: in quo uti ingenium admiror, quoties medicamentorum vires, aut morborum cauſas explicat, ſic ubi forum ſuum egreſſus, Philoſophum agit, ac vel Partium uſum, vel Chymicarum rerum naturam ſcrutetur, ejus haud ſemel non modo judicium deſidero, verùm aliquando etiam fidem.* This is ſo ſevere and unjuſt a Cenſure of our truly famous Countryman, (a Man of known Probity) that might deſerve a better Anſwer: But I have only Time to ſay, that although Dr. *Schelhammer* hath out-done all that wrote before him, in his Book *de Auditu*, and ſhewed himſelf a Man of Learning and Induſtry: yet, as our Countryman wrote more than he, (though perhaps not free from Errors too) ſo he hath manifeſted himſelf to have been as curious and ſagacious an Anatomiſt, as great a Philoſopher, and as learned and ſkilful a Phyſician, as any of his Cenſurers; and his Reputation for Veracity and Integrity, was no leſs than any of theirs too. But after all this terrible Clamour, Dr. *Schelhammer* prejudicately miſtaketh Dr. *Willis*'s Meaning, to ſay no worſe. For by *utræque Membranæ refringunt*, Dr. *Willis* plain enough, I think, means no more than a Reſtriction of the Ingreſs of too many Rays; as his following explicatory Words manifeſt, *viz. refringunt, & quaſi emolliunt, eaſque Senſorio non niſi proportionatas tradunt.* But indeed Dr. *Schelhammer* hath ſhewn himſelf a too rigid Cenſor, by making Dr. *Willis* ſay, the *Ear Drum* hath ſuch like Braces as the *War Drum*, *viz. Quod porrò de machinis ſeu tæniis Tympani bellici adducit, dicitque idem in Tympano auditorio conſpici, id prorſus falſiſſimum eſt.* I wonder Dr. *Schelhammer* did not alſo charge Dr. *Willis* with making it a Porter, ſince he hath in the ſame Paragraph, *Janitoris officio, &c.* But Dr. *Willis*'s Meaning is plain enough, that the little Bones and Muſcles of the *Ear Drum* do the ſame Office in ſtraining and relaxing it, as the Braces of the *War Drum* do in that. And conſidering how curious and ſolemn an Apparatus there is of Bones, Muſcles, and Joints, all adapted to a ready Motion, I am clearly of Dr. *Willis*'s Opinion, that one great Uſe of the
Ear

Ear Drum is for the proportioning Sounds; and that by its Extenſion and Retraction, it correſponds to all Sounds, loud or languid, as the Pupil of the Eye doth to ſeveral Degrees of Light: And that they are no other than ſecondary Uſes aſſigned by Dr. *Schelhammer*, as the principal or ſole Uſes of keeping out the external cold Air, Duſt, and other Annoyances; but eſpecially that, *Ob ſolius aeris interni potiſſimùm irrumpentis vim, hunc motum Tympani ac Mallei eſſe conditum, ut cedere primùm, deinde ſibi reſtitui queat*; as his Words are, *Par. ult. cap.* vi. *ſect.* 13.

It was no improbable Thought of *Rohault*, *Nos attentos præbere, nil aliud eſt, niſi* Tympanum, *ubi ita opus eſt facto, contendere aut laxare, & operam dare ut illud in eâ poſitione intentum ſtet, in quâ tremulum aeris externi motum commodiſſimè excipere poſſit.* Roh. Phyſ. p. i. cap. 26. ſect. 48.

The Hearing of deaf Perſons more eaſily by Means of loud Noiſes, is another Argument of the Uſe of the Straining or Relaxation of the *Tympanum* in Hearing. Thus Dr. *Willis* (ubi ſupra) *Accepi olim à viro fide digno, ſe mulierem noviſſe, quæ licèt ſurda fuerit, quouſque tamen intra conclave Tympanum pulſaretur, verba quævis clarè audiebat: quare Maritus ejus Tympaniſtam pro ſervo domeſtico conducebat, ut illius ope, colloquia interdum cum Uxore ſuâ haberet. Etiam de alio Surdaſtro mihi narratum eſt, qui prope Campanile degens, quoties unà plures Campanæ reſonarent, vocem quamvis facilè audire, & non aliàs, potuit.*

Abſciſſo Muſculo [Proceſſus majoris Mallei] *in recenti aure, relaxatur* [Tympani Membrana.] *Valſalv. de Aur. Hum.* cap. ii. ſect. 5.

Upon conſidering the great Difference in Authors Opinions, about the Uſe of the Parts, and Manner how Hearing is performed, as alſo what a curious Proviſion there is made in the Ear, by the four little Bones, the Muſcles, Membranes, &c. I was minded (ſince I penned this Note) to make Enquiry myſelf into this Part, and not to rely upon Authority. And after a diligent Search of various Subjects, I find we may give as rational and eaſy an Account of Hearing, as of Seeing, or any other Senſe; as I have ſhewn in my laſt cited *Note (d)*, *Book* VII. *Chap.* ii. with Relation to Birds. And as to Men and Beaſts, the Caſe is the ſame, but the Apparatus more complex and magnificent. For whereas in Birds, the *auditory Nerve* is affected by the Impreſſions made on the *Membrane*, by only the Intermediacy of the *Collumella*; in Man, it is done by the Intervention of the four little Bones, with the Muſcles acting upon them; his Hearing being to be adjuſted to all Kinds of Sounds, or Impreſſions made upon the *Membrana Tympani*. Which Impreſſions are imparted to the *auditory Nerve*, in this Manner, *viz.* Firſt they act upon the *Membrane* paſs to that of the *Labyrinth* (w), and therein ſurvey the curious and admirable Structure of the *Veſtibulum*, the *Semicircular Canals* (x), and *Cochlea*; particularly the artificial Gyrations, and other ſingular Curioſities obſervable in the two latter.

But I ſhall not expatiate on theſe recluſe Parts; only there is one ſpecial Contrivance of the Nerves

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brane and *Malleus*, the *Malleus* upon the *Incus*, and the *Incus* upon the *Os Orbiculare* and *Stapes*; and the *Stapes* upon the *auditory Nerve*: For the Baſe of the *Stapes* (the ſame as the *Operculum* in Birds) not only covers the *Feneſtra Ovalis*, within which the *auditory Nerve* lieth, but hath a Part of the *auditory Nerve* ſpread upon it too. It is manifeſt that this is the true Proceſs of Hearing; becauſe if the *Membrane* be moved, you may ſee all the Bones move at the ſame Time, and work the Baſe of the *Stapes* up and down in the *Feneſtra Ovalis*, as I ſhewed in this Chapter, *Note (d)*, concerning the *Mole*; and as it may be ſeen in other Ears, carefully opened, if the Parts remain *in ſitu*.

(*w*) I do not confine the *Labyrinth* to the *Canales Semicirculares*, or any other Part, as the elder Anatomiſts ſeem to have done, who, by their erroneous and blind Deſcriptions, ſeem not well to have underſtood theſe Parts; but with thoſe much more curious and accurate Anatomiſts Monſieur *de Vernay*, and Dr. *Valſalva*, under the *Labyrinth* I comprehend the *Canales Semicirculares*, and the *Cochlea*, together with the intermediate Cavity, called by them the *Veſtibulum*.

(*x*) In the *ſemicircular Canals* two Things deſerve to be noted. 1. That the three Canals are of three different Sizes, *Major*, *Minor*, and *Minimus*. 2. Although in different Subjects, they are frequently different, yet in the ſame Subject they are conſtantly the ſame. The Reaſon of all which, together with the Uſes, *Valſalva* ingeniouſly thinks is, that as a Part of the tender *auditory Nerve* is lodged in theſe Canals, ſo they are of three Sizes, the better to ſuit all the Variety of Tones; ſome of the Canals ſuiting ſome, and others, other Tones. And although there be ſome Difference as to the Length and Size of theſe Canals, in different Perſons; yet, leſt there ſhould be any Diſcord in the auditory Organs of one and the ſame Man, thoſe Canals are always in exact Conformity to one another in one and the ſame Man. *Vide Valſal. ubi ſupra*, cap. iii. ſect. 7. and cap. vi. ſect. 4, 9.

miniſtring to this Senſe of Hearing, which muſt not be paſſed by; and that is, the Branches of one of the *auditory Nerves* (y) ſpread partly to the Muſcles of the Ear, partly to the Eye, partly to the Tongue and Inſtruments of Speech, and inoſculated with the Nerves to go to the Heart and Breaſt. By which Means there is an admirable and uſeful Conſent between theſe Parts of the Body; it being natural for moſt Animals, upon the hearing any uncouth Sound, to erect their Ears, and prepare them to catch every Sound; to open their Eyes (thoſe conſtant faithful Centinels) to ſtand upon their Watch; and to be ready with the Mouth to call out, or utter what the preſent Occaſion ſhall dictate. And accordingly it is very uſeful for moſt Animals, when ſurpriz'd and terrify'd with any Noiſe, preſently to ſhriek and cry out.

But there is beſides this, in Man, another great Uſe of this nervous Commerce between the Ear and Mouth; and that is, (as one of the beſt Authors on this Subject expreſſeth it) (z), "That the Voice "may correſpond with the Hearing, and be a kind "of Echo thereof, that what is *heard* with *one* of "the two Nerves, may be readily expreſſed with the "Voice, by the Help of the *other*."

(y) *Hic poſterior Nervus extra cranium delatus, in tres ramos dividitur, qui omnes motibus patheticis — inſerviunt. Primus muſculis Auris impenditur. Proculdubio hujus actione efficitur, ut animalia quævis, a ſubito ſoni impulſu, aures quaſi ſonum nimis citò tranſeuntem captaturas erigant. Ramus alter —— verſus utrumque oculi angulum ſurculos emittit: qui muſculis palpebrarum attollentibus inſeruntur; quorum certè munus eſt ad ſubitum ſoni appulſum oculos confeſtim aperire, eoſque velut ad Excubias vocare — Tertius — ramus verſus Linguæ radicem deſcendens, muſculis ejus & oſſis Hyoideos diſtribuitur, adeòque organa quædam vocis edendæ actuat, &c. Willis*'s Cereb. Anat. cap. 7.

(z) *Hujuſmodi Nervorum conformatio in Homine uſum alium inſigniorem præſtat, nempe ut Vox,* &c. Willis ibid.

Thus much ſhall ſuffice to have ſpoken concerning the Organ. Let us,

II. Take Notice of the *Object* of this admirable Senſe, namely, *Sound*; and ſo conclude this Chapter. I ſhall not here enquire into the Nature and Properties of *Sound*, which is in a great meaſure intricate, and hath puzzelled the beſt Naturaliſts: Neither will I ſhew how this admirable Effect of the divine Contrivance, may be improved to divers Uſes (aa) and Purpoſes in human Life; but my Buſineſs

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(aa) Among the Uſes to which the Wit of Man hath employed Sounds, we may reckon the Inſtruments uſeful in convocating Aſſemblies, managing Armies, and many other Occaſions, wherein Bells, Trumpets, Drums, Horns, and other ſounding Inſtruments are uſed; the Particularities of which it would be tedious to recount: As that the biggeſt *Bell* in *Europe* is reckoned to be at *Erfurt* in *Germany*, which they ſay may be heard twenty-four Miles, with much more to the ſame Purpoſe. I ſhall therefore only for a Sample take Notice of the *Speaking-Trumpet*; the Invention of which is commonly aſcribed to our eminent Sir *Samuel Morland*; but was more probably *Ath. Kircher*'s; at leaſt he had contrived ſuch an Inſtrument before Sir *Samuel* hit upon his. *Kircher*, in his *Phonurg.* ſaith, the *Tromba* publiſhed laſt Year in *England*, he had invented twenty-four Years before, and publiſhed in his *Miſurgia*; that *Jac. Albanus Ghibbeſius*, and *Fr. Eſchinardus*, aſcribe it to him; and that *G. Schottus* teſtifieth he had ſuch an Inſtrument in his Chamber in the *Roman College*, with which he could call to, and receive Anſwers from the Porter. And conſidering how famed *Alexander the Great*'s Tube was, which is ſaid might be heard 100 *Stadia*, it is ſomewhat ſtrange that no body ſooner hit upon the Invention, Of this *Stentorophonick Horn* of *Alexander*, there is a Figure preſerved in the *Vatican*, which, for Curioſity ſake, I have, from *Kircher*, repreſented in *Fig.* 3. He ſaith its Diameter was five Cubits, and that it was ſuſpended on a Supporter.

For the Make of the *Speaking-Trumpet*, and the Reaſon why it magnifies Sounds, I ſhall refer to *Kircher*, eſpecially to Sir *Samuel Morland's Tuba Stentorophonica*, publiſhed in 1672.

Kircher ſaith, he took one of theſe Trumpets of fifteen Palms Length, along with him to the *Mons Euſtachianus*, where he convocated 2200 Perſons to Prayers, by Means of the unuſual Sound, at two, three, four, and five *Italian* Miles Diſtance.

Buſineſs will be to ſhew that this Thing, of ſo admirable Uſe in the animal World, is the Work of God. And this will appear, let the Subject Matter of Sounds be what it will; either the Atmoſphere *(bb)* in groſs, or the ætherial Part thereof, or

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With theſe *Bellowing-Trumpets*, I ſhall join ſome *Bellowing-Caves* for the Reader's Diverſion. *Ol. Magnus* deſcribes a Cave in *Finland*, near *Viburg*, called *Smellen*, into which, if a Dog, or other living Creature be caſt, it ſends forth ſo dreadful a Sound, that knocks down every one near it. For which Reaſon they have guarded the Cave with high Walls, to prevent the Miſchiefs of its Noiſe. *Vide Ol. Magn. Hiſt.* lib. xi. cap. 4. Such another *Peter Martyr* ſaith is in *Hiſpaniola*, which, with a ſmall Weight caſt into it, endangers Deafneſs at five Miles Diſtance. And in *Switzerland*, *Kircher* ſaith, in the *Cucumer Mountain* is a Pit that ſends out both a dreadful Noiſe and a great Wind therewith; and that there is a Well in his Country, 3000 Palms deep, whoſe Sound is equal to that of a great Gun. *Vide Kircher. Phonurg.*

Ol. Magnus, ſpeaking of the vaſt high Mountains of a Northern Province, called *Angermannia*, ſaith, *Ubi baſes eorum in profundiſſimo gurgite ſtantes, caſu aliquo, vel propoſito Nautæ acceſſerint, tantum horrorem ex altâ fluctuum colliſione percipiunt, ut niſi præcipiti remigio, aut valido vento evaſerint, ſolo pavore ferè exanimes fiant, multoque dierum curriculo, ob capitis turbationem, priſtinæ mentis, & ſanitatis compotes vix evadant. Habent baſes illorum montium in fluctuum ingreſſu & regreſſu tortuoſas rimas, ſive ſciſſuras, ſatis ſtupendo naturæ opificio fabricatas, in quibus longâ varagine formidabilis ille Sonitus quaſi ſubterraneum tonitru generatur.* Ol. Magn. lib. ii. cap. 4. See alſo cap. 12.

(bb) That the Air is the Subject, or *Medium* of Sound, is manifeſt from the Experiments in rarefied and condenſed Air. In an unexhauſted Receiver, a ſmall Bell may be heard at the Diſtance of ſome Paces; but when exhauſted, it can ſcarce be heard at the neareſt Diſtance: and if the Air be compreſſed, the Sound will be louder, proportionably to the Compreſſion or Quantity of Air crouded in, as I have often tried myſelf, and may be ſeen in Mr. *Hawkſbee*'s curious Experiments, p. 97. Alſo his Experiments in *Phil. Tranſ.* N° 321.

Neither doth this ſucceed only in forced Rarefactions and Condenſations of the Air, but in ſuch alſo as are natural; as is evident from *David Frœdlichius* in *Varenius*, upon the higheſt Eminences of *Carpathus*, near *Keſmarckt*, in *Hungary*. The Story of *Frœdlichius* is this: *Ego menſe Junii* 1615. *tum adoleſcens,* or ſoniferous Particles of Bodies, as ſome fancy, or whatever elſe Philoſophers may think it. For who

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leſcens, ſublimitatem horum montium, cum duobus comitibus Scholaribus, experiri volens, ubi, cùm in primæ rupis vertice, magno labore, me ſummum terminum aſſecutum eſſe putarem, demum ſeſe obtulit alia multo altior cautes, ubi pervaſta eaque vacillantia ſaxa (quorum unum, ſi loco à viatore dimovetur — aliquot centena — rapit, & quidem tanto cum fragore, ut illi metuendum ſit nè totus Mons corruat, eumque obruat) enixus eſſem, iterum alia ſublimior prodiit, &c. donec ſummo vitæ periculo ad ſupremum cacumen penetraverim. Ex declivioribus montibus cum in ſubjectas valles, — nil niſi obſcuram noctem, aut cæruleum quid, inſtar profundi aëris, quod vulgò ſudum cælum appellatur, obſervare potui mihique videbar, ſi de monte caderem, non in terram, ſed rectè in ſolum me prolapſurum. Nimia enim declivitate, ſpecies viſibiles extenuatæ & hebetatæ fuerunt. Cum verò altiorem montem peterem, quaſi intra nebulas denſiſſimas hærebam — Et cum non procul à ſummo vertice eſſem de ſublimi quieſcens proſpexi & animadverti iis in locis, ubi mihi antea videbar intra nebulas hæſiſſe, compactas atque albas ſeſe movere nubes, ſupra quas, per aliquot milliaria, & ultra terminos Sepuſi commodus mihi proſpectus patuit. Alias tamen etiam nubes altiores, alias item humiliores, necnon quaſdam æqualiter à terrâ diſtantes vidi. Atque hinc tria intellexi, 1. Me tum tranſiviſſe principium mediæ Aeris regionis. 2. Diſtantiam nubium à terra, non eſſe æqualem. — 3. Diſtantiam nubium — non 72 Mill. Ger. ut quidam — ſed tantum dimidiatum Mill. Ger. In ſummum montis verticem cum perveniſſem, adeò tranquillum & ſubtilem aërem ibi offendi, ut nè pili quidem motum ſentirem, cùm tamen in depreſſioribus ventum vehementem expertus ſim : unde collegi ſummum cacumen iſtius montis Carpathici ad Mill. Germ. à radicibus ſuis imis exſurgere, & ad ſupremam uſque aëris regionem, ad quam Venti non aſcendunt, pertingere. Exploſi in eâ ſummitate Sclopetum : quod non majorem ſonitum primò præ ſe tulit, quàm ſi ligillum vel bacillum confregiſſem ; poſt intervallum autem temporis murmur prolixum invaluit, inferioreſque montis partes, convalles & ſylvas opplevit. Deſcendendo per nives annoſas intra convalles, cùm iterum Sclopetum exonerarem, major & horribilior fragor, quàm ex tormento capaciſſimo inde exoriebatur : hinc verebar nè totus mons concuſſus mecum corrueret : duravitque hic ſonus per ſemiquadrantem horæ uſque dum abſtruſiſſimas cavernas penetrâſſet, ad quas aër undique multiplicatus reſiliit. — In his celſis montibus, plerumque ningit grandinatve mediâ æſtate, quoties nempe in ſubjectâ & vicinâ planitie pluit, uti hoc ipſum expertus ſum. Nives diverſorum annorum ex colore & cortice duriore dignoſci poſſunt. Varen. Geogr. Gen. lib. i. cap. 19. prop. ult.

who but an intelligent Being, what leſs than an omnipotent and infinitely wiſe God could contrive, and make ſuch a fine Body, ſuch a Medium, ſo ſuſceptible of every Impreſſion, that the Senſe of Hearing hath Occaſion for, to empower all Animals to expreſs their Senſe and Meaning to others; to make known their Fears, their Wants, their Pains, and Sorrows in melancholick Tones; their Joys and Pleaſures in more harmonious Notes; to ſend their Minds at great Diſtances *(cc)*, in a ſhort Time

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The Story being diverting, and containing divers Things remarkable, I have choſen to note the whole of it (although ſomewhat long) rather than ſingle out the Paſſages only which relate to the diminiſhing the Sound of his Piſtol, by the Rarity of the Air at that great Aſcent into the Atmoſphere; and the magnifying the Sound by the Polyphoniſms or Repercuſſions of the Rocks, Caverns, and other Phonochamptick Objects below in the Mount.

But it is not the Air alone that is capable of the Impreſſions of Sound, but the Water alſo, as is manifeſt by ſtriking a Bell under Water, the Sound of which may plain enough be heard, but it is much duller, and not ſo loud; and it is alſo a fourth deeper, by the Ear of ſome great Judges in Muſical Notes, who gave me their Judgments in the Matter. But *Merſenne* ſaith, a Sound made under Water, is of the ſame Tone or Note, if heard under Water; as are alſo Sounds made in the Air, when heard under Water. *Vide Merſen. Hydraul.*

Having mentioned the hearing of Sounds under Water, there is another Curioſity worth mentioning, that alſo farther proves Water to be ſuſceptible of the Impreſſions of Sound, *viz. Divers* at the Bottom of the Sea, can hear the Noiſes made above, only confuſedly. But, on the contrary, thoſe above cannot hear the Divers below. Of which an Experiment was made, that had like to have proved fatal: One of the Divers blew an Horn in his Diving Bell, at the Bottom of the Sea; the Sound whereof (in that compreſſed Air) was ſo very loud and irkſome, that it ſtunned the Diver, and made him ſo giddy, that he had like to have dropped out of his Bell, and to have been drowned. *Vide Sturmii Colleg. Cur. Vol.* ii. *Tentam.* I.

(cc) As to the Diſtance to which Sound may be ſent, having ſome doubt, whether there was any Difference between the Northern and Southern Parts, by Favour of my learned and illuſtrious Friend, Sir *Henry Newton*, her late Majeſty's Envoy at *Florence*, I procured ſome Experiments to be made for me in *Italy*.

Time *(dd)*, in loud Boations; or to expreſs their Thoughts near at hand with a gentle Voice, or in ſecret Whiſpers! And to ſay no more, who leſs than the ſame moſt wiſe and indulgent Creator, could form ſuch an Œconomy, as that of Melody and Muſick is; That the *Medium* ſhould (as I ſaid) ſo readily receive every Impreſſion of Sound, and

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Italy. His moſt Serene Highneſs the *Great Duke* was pleaſed to order great Guns to be fired for this Purpoſe at *Florence*, and Perſons were appointed on purpoſe to obſerve them at *Leghorn*, which they compute is no leſs than 55 Miles in a ſtrait Line. But notwithſtanding the Country between being ſomewhat hilly and woody, and the Wind alſo was not favouring, only very calm and ſtill, yet the Sound was plainly enough heard. And they tell me, that the *Leghorn* Guns are often heard 66 Miles off, at *Porto Ferraro*; that when the *French* bombarded *Genoa*, they heard it near *Leghorn*, 90 Miles diſtant; and in the *Meſſina Inſurrection*, the Guns were heard from thence as far as *Auguſta* and *Syracuſe*, about 100 *Italian* Miles. Theſe Diſtances being ſo conſiderable, give me reaſon to ſuſpect, that Sounds fly as far, or nearly as far, in the Southern as in the Northern Parts of the World, notwithſtanding we have a few Inſtances of Sounds reaching farther Diſtances. As Dr. *Hearn* tells us of Guns fired at *Stockholm*, in 1685, that were heard 180 *Engliſh* Miles. And in the *Dutch* War, 1672, the Guns were heard above 200 Miles. *Vide Phil. Tranſ.* N° 113. Alſo there is this farther Reaſon of Suſpicion, that the *Mercury* in the *Barometer* riſeth higher without than within the Tropicks, and the more Northerly, ſtill the higher, which may increaſe the Strength of Sounds, by *Note (bb)*.

(dd) As to the Velocity of Sounds, by Reaſon the moſt celebrated Authors differ about it, I made divers nice Experiments myſelf, with good Inſtruments; by which I found, 1. That there is ſome, although a ſmall Difference, in the Velocity of Sounds, with or againſt the Wind: Which alſo is, 2. Augmented or diminiſhed by the Strength or Weakneſs of the Wind. But that nothing elſe doth accelerate or retard it, not the Differences of Day or Night, Heat or Cold, Summer or Winter, Cloudy or Clear, Barometer high or low, &c. 3. That all Kinds of Sounds have the ſame Motion, whether they be loud or languid, of Bells, Guns, great or ſmall, or any other ſonorous Body. 4. That they fly equal Spaces in equal Times. Fifthly and laſtly, That the Mean of their Flight is at the Rate of a Mile in 9 half Seconds and a quarter, or 1142 Feet in one Second of Time. *Vide Phil. Tranſ. ibid.*

convey the melodious Vibration of every muſical String, the harmonious Pulſes of every animal Voice, and of every muſical Pipe; and the Ear be as well adapted, and ready to receive all theſe Impreſſions, as the *Medium* to convey them: And laſtly, that by Means of the curious Lodgment, and Inoſculation of the *Auditory Nerves* before-mentioned, the Orgaſms of the Spirits ſhould be allayed, and Perturbations of the Mind, in a great Meaſure, quieted and ſtilled (*ee*): Or, expreſs it in the Words

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(*ee*) *Timothy* a Muſician could excite *Alexander the Great* to Arms with the *Phrygian* Sound, and allay his Fury with another Tone, and excite him to Merriment. So *Ericus* King of *Denmark*, by a certain Muſician, could be driven to ſuch a Fury, as to kill ſome of his beſt and moſt truſty Servants. More of this Power of Muſick over the Affections, may be ſeen in *Ath. Kircher. Phonurg.* lib. ii. ſect. 1. Alſo in *Iſ. Voſſius de Poematum cantu & Rythmi viribus.*

And not only upon the Affections, but alſo on the Parts of the Body, Muſick is able to exert its Force, as appears from the *Gaſcoigne* Knight, *Cui Phormingis ſono audito Veſica ſtatim ad Urinam reddendam vellicabatur.* Such another we have in A° 1. *Ephem. Nat. Curioſ. Obſerv.* 134. Alſo *Morhoff. de Scyph. vitr. per cert. human. vocis ſonum fracto*; where there is not only the Account of the *Dutchman* at *Amſterdam*, one *Nich. Peter*, that brake Romer-Glaſſes with the Sound of his Voice; but alſo divers other Inſtances of the Powers and Effects of Sound. But to the Story of the *Gaſcoigne* Knight, Mr. *Boyle*, from *Scaliger*, adds a pleaſant Paſſage, That one he had diſobliged, to be even with him, cauſed at a Feaſt, a Bag-pipe to be played, when he was hemmed in with the Company; which made the Knight be-piſs himſelf, to the great Diverſion of the Company, as well as Confuſion of himſelf. *Boyle*'s *Eſſay of the Effect of Lang. Motion.* In the ſame Book are other Matters that may be noted here. One whoſe Arm was cut off, was exceedingly tormented with the Diſcharge of the great Guns at Sea, although he was at a great Diſtance on Land. And a great Ship-Commander obſerved his wounded Men, with broken Limbs, ſuffered in like manner at the Enemies Diſcharges. An ingenious Domeſtic of his own would have his Gums bleed at the tearing of brown Paper. And an ingenious Gentleman of Mr. *Boyle*'s Acquaintance confeſſed to him, that he was inclined to the *Knight of Gaſcoigne*'s Diſtemper, upon hearing the Noiſe of a Tap running. The Dancing to certain Tunes, of Perſons

Words of the laſt-cited famous Author (ff), "That "Muſick ſhould not only affect the Fancy with "Delight, but alſo give Relief to the Grief and

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Perſons bit with the *Tarantula*, he was aſſured of by an ingenious Acquaintance at *Tarentum*, who ſaw ſeveral, among the reſt a Phyſician, affected with that Diſtemper. And many other Accounts of this Kind, ſeemingly credible, are related in *Morhoff*, *Kircher*, and many others; although Dr. *Cornelio* queſtions the Matters of Fact relating to the Cure of the *Tarantula* Bite, in *Philoſ. Tranſ.* N° 83. Mr. *Boyle* alſo ſaith, a ſober Muſician told him, he could make a certain Woman weep, by playing one Tune, which others would be little affected at. And he ſaith, that he himſelf had a kind of ſhivering at the repeating two Verſes in *Lucan*. And I add, that I very well knew one to have a ſort of Chill about his *Præcordia* and Head, upon reading or hearing the 53d Chapter of *Iſaiah*; as alſo *David*'s Lamentations for *Saul* and *Jonathan*, 2 *Sam.* i.

Neither are our Minds and Bodies only affected with Sounds, but inanimate Bodies are ſo alſo. Of which many Stories may be met with in *Kircher*, particularly a large Stone that would tremble at the Sound of one particular Organ-Pipe; in *Morhoff* alſo, who, among many other Relations, hath this: *Memini cùm ipſi [clariſſ. Williſio] de experimento Vitri per vocem fracti narrarem, ex eo audiviſſe, quod in ædibus Muſicis ſibi vicinis aliquoties collapſum pavimentum fuerit; quod ipſe ſonis continuis adſcribere non dubitavit.* Morhoff, cap. 12. *Merſenne* alſo, among many Relations, in his *Harmon.* and other Books, tells a far more probable Story, of a Particular Part of a Pavement, that would ſhake, as if the Earth would open, when the Organs played, than what he relates about *Antipathy*, in his *Quæſt. Comment in Geneſ.* viz. That the Sound of a Drum made of a Wolf's Skin, will break another made of Sheep's Skin: That Hens will fly at the Sound of an Harp ſtrung with Fox-Gut Strings; and more to the ſame Purpoſe. Mr. *Boyle* alſo, in his laſt cited Book, tells us, Seats will tremble at the Sound of Organs; and that he hath felt his Hat to do ſo too under his Hand, at certain Notes both of Organs, and in Diſcourſe; that he tried an Arch that would anſwer to C-fa-ut, and had done ſo an hundred Years; and that an experienced Builder told him, any well-built Vault will anſwer ſome determinate Note. And at *Eaſtbury-Houſe*, near *Barking*, I myſelf diſcovered the Porch (having firm Brick-Walls,) not only to ſound, when ſtruck on the Bottom, but alſo to give almoſt as loud a Sound, when I ſounded the ſame Note with my Voice.

(ff) *Willis*, ubi ſupra.

“ Sadneſs of the Heart; yea, appeaſe all thoſe turbulent Paſſions, which are excited in the Breaſt by an immoderate Ferment, and Fluctuation of the Blood.”

And now, who can reflect upon all this curious Apparatus of the *Senſe of Hearing*, and not give the great Creator his due Praiſe! Who can ſurvey all this admirable Work, and not as readily own it to be the Work of an omnipotent, and infinitely wiſe and good God (gg), as the moſt artful Melodies we hear, are the Voice or Performances of a living Creature!

(gg) *Ille Deus eſt—qui non calamo tantùm cantare, & agreſte, atque inconditum carmen ad aliquam tantùm oblectationem modulari docuit, ſed tot artes, tot vocum varietates, tot ſonos, alios ſpiritu noſtro, alios externo cantu edituros commentus eſt.* Senec. de Beneſ. lib. iv. cap. 6.

CHAP. IV.

Of the Senſe of Smelling.

THIS Senſe I ſhall diſpatch in leſs Compaſs than the two laſt, becauſe its Apparatus (although ſufficiently grand and admirable, yet) is not ſo multiplicious as of the Eye and Ear; it being ſufficient in this Senſe, that the odoriferous Effluvia of Bodies (a) can have an eaſy, free Paſſage to the olfactory Nerves, without the Formalities of Refractions, and other Preparations neceſſary to the Perfection of the two former Senſes. Accordingly, the all-wiſe Creator hath made ſufficient Proviſion for the Reception of Smells, by the Aperture of the Noſtrils (b); made not of Fleſh, or Bone, but cartilaginous, the better to be kept open, and withal, to be dilated or contracted, as there is Occaſion: For which Service it hath ſeveral proper and curious Muſcles (c).

(a) A Piece of *Ambergreaſe* ſuſpended in a Pair of Scales that would turn with a very ſmall Part of a Grain, loſt nothing of its Weight in three Days and a half; neither did *Aſſafœtida* in five Days and a half: But an Ounce of *Nutmegs* loſt five Grains and a half in ſix Days; and *Cloves*, ſeven Grains and four fifths. *Boyle's Subtil. of Effluv.* chap. 5.

(b) *Nares, eò quòd omnis Odor ad ſuperiora fertur, rectè ſurſum ſunt: Et quòd Cibi & Potionis judicium magnum earum eſt, non ſine cauſâ vicinitatem Oris ſecutæ ſunt.* Cic, de Nat. Deor. lib. ii. cap. 56.

(c) Had not the Contriver of Animal Bodies been minded that his Work ſhould have all the Signatures of Accuracy, this Senſe might have been performed by a bare Aperture of the Noſe; but that nothing might go imperfect out of his Hand,

And foraſmuch as it is by Breathing *(d)*, that the odorant Particles are drawn in, and conveyed to the Senſory; thereof there is a very wiſe Proviſion made in the *Laminæ*, with which the upper Part of the Noſe is barricaded, which ſerve to two excellent Uſes: Partly, to fence out any noxious Subſtances from entering the breathing Paſſages in our Sleep, or when we cannot be aware *(e)*; and partly to receive the Divarications of the *olfactory Nerves*, which are here thick ſpread, and which do by theſe Means meet the Smells entering with the Breath, and ſtriking upon them.

And accordingly, the more accurate this Senſe is in any Animal, the longer we may obſerve thoſe *Laminæ* are; and more of them in Number folded up, and crouded together, to contain the more nervous Filaments, and to detain and fetter the odoriferous Particles in their Windings and Turnings.

And an admirable Proviſion this is, which the great Creator hath made for the Good of brute Creatures *(f)*; the chief Acts of many of whoſe Lives

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he hath made a Part of the Noſe eaſily moveable, and given a Set of Muſcles to lift up, and open and ſhut the Noſtrils; and ſo adjuſt it to every Occaſion of this Senſe.

(d) *Odorem non aliud, quàm infectum Aëra, intelligi poſſe.* Plin. Nat. Hiſt. lib. ix. cap. 7.

(e) For a farther Guard againſt the Ingreſs of noxious Things, the *Vibriſſæ*, or Hairs placed at the Entrance of the Noſtrils, ſerve; which, in ſome Meaſure, ſtop the Entrance of Things improper, or, however, give Warning of them; but at the ſame time allow an eaſy Paſſage to the Breath and Odours.

(f) *Multò præclarius emicat* [*Olfactus*] *in brutis animalibus, quàm in homine: iſta namque hoc ſolo indice, herbarum, aliorumque corporum priùs ignotorum virtutes certiſſimè dignoſcunt, quin & victum ſuum abſentem, vel in abſtruſo poſitum, Odoratu venantur, ac facillimè inveſtigant. Quòd autem minùs ſagaces ſunt hominum nares, illud non facultatis hujus abuſui (prout nonnulli volunt) aſcribi debet, verùm in cauſâ eſt ipſius Organi defectus: hoc enim circa victûs humani criteria (ubi ratio, & intellectus adſunt) non ita accuratum requiritur; Propterea enim inferiores potentiæ in homine*

Lives are perform'd by the Miniſtry of this Senſe. In Inſects, and many other Creatures, it is of great Uſe in the Propagation of their Kind; as particularly in helping them to ſafe and convenient Places for the Incubation of their Eggs, and breeding up their Young. Others are by the Accuracy of this Senſe, of Uſe to Mankind, which would be otherwiſe of little or no Uſe *(g)*. And moſt of the irrational Animals, Birds, Beaſts, and creeping Things, do, by their Smell, find out their Food; ſome at great Diſtances, and ſome at Hand. With what Sagacity do ſome diſcover their Food in the Midſt of Mud and Dirt *(h)*? With what Curioſity do the herbaceous Kind pick and chuſe ſuch Plants as afford them wholſome Food, or ſometimes ſuch as are Medicinal *(i)*, and refuſe ſuch as would hurt and deſtroy them? And all by the Help principally, if not only, of the Smell, aſſiſted by its near Ally the Taſte. Of which I ſhall in the next Place ſpeak very briefly.

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mine, à naturâ minùs perfectæ exiſtunt, ut ſuperiorum cultui & exercitio relinqueretur locus. Willis de Anim. Brut. cap. 13.

(g) Thus the chief Uſe of Hounds is to hunt; and other Dogs, to be a Watch and Guard to our Houſes by Night. For which Services (particularly in Hounds) their *Olfactory Nerves* are not only remarkably larger (like as they are in other Brutes), but their Branches and Filaments are, in the *Laminæ* of the Noſtrils, both more and larger than I have ſeen in any other Creature whatſoever. Alſo there are more Convulſions of the *Laminæ* than I ever remember to have found in any other Animal.

The Sagacity of Hounds is prodigious; of which ſee an Inſtance in *Book* IV. *Chap.* xi. *Note (bbb)*.

(h) See *Book* VII. *Chap.* ii. *Note (e)*.

(i) Vide Plin. Hiſt. Nat. lib. viii. cap. 27. *Quæ animalia quas herbas oſtenderunt.*

CHAP. V.

Of the Taſte (a).

IN this, as in the laſt Senſe, we have an *Apparatus* abundantly ſufficient to the Senſe; Nerves curiouſly divaricated about the Tongue *(b)*, and Mouth, to receive the Impreſſions of every Guſto; and

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(a) Τὰ δὲ εἴδη τῶν χυλῶν, &c. *Saporum genera, — dulcis, pinguis, auſterus, acerbus, acris, ſalſus, amarus, acidus.* Theophr. de Cauſ. Plant. lib. vi. cap. 1. What may be the Cauſe of the Difference of Taſtes, he ſaith, is hard to aſſign, πότερον γὰρ τοῖς πάθεσι, &c. *Utrum affectionibus Senſuum — an figuris, quibus ſinguli conſtant, ut Democritus cenſet*, id. ibid. Δημόκριτος δὲ, &c. *Democritus — dulcem eſſe ſaporem qui rotundus; acerbum qui figurâ magnâ; aſperum qui multis angulis*, &c. Id. ib. &c. But of the Diverſities and Cauſes of Taſtes, ſee Dr. *Grew, Lect.* 6. and Dr. *Willis de Anim. Brut.* cap. 12.

(b) Intellectus Saporum eſt cæteris in primâ linguâ: Homini, & in palato. Plin. lib. xi. cap. 37.

The Opinions of the Anatomiſts concerning the Organ of *Taſte*, are various. *Bauhin. T. Bartholin. Bartholette, Veſlinge, Deuſinge*, &c. place it in the laxer, fleſhy Parts of the Tongue. Our famous *Wharton*, in the Gland at the Root of the Tongue: *Laurentius*, in the thin Tunick covering the Tongue; but the learned *Malpighi*, with great Probability, concludes, becauſe the outward Cover of the Tongue is perforated, under which lie papillary Parts, (of which Mr. *Cowper* hath very good Cuts in his *Anat. Tab.* 13.) that in theſe the Taſte lieth. *Malpighi*'s Words are, *Quare cùm dictis meatibus inſignibus occurrant papillarea corpora, probabilius eſt in his ultimo, ex ſubintranti ſapido humore titillationem, & mordicationem quandam fieri, quæ Guſtum efficiat.* Malpig. Op. Tom. ii. De Linguâ, p. 18.

Præcipuum ac ferè ſolum Guſtatûs organon eſt Lingua; cui aliquatenus ſubobſcurè tamen Palatum, & ſuperior Gulæ pars conſentiunt; in omnibus verò fibræ nervoſæ immediata ſenſionis inſtrumenta

and theſe Nerves guarded with a firm and proper Tegument to defend them from Harms; but withal, ſo perforated in the papillary Eminences, as to give a free Admiſſion to Taſtes.

But I ſhall ſay no more of this Senſe; only a Word or two of its Conſent with the Smell, and the Situation of them both: Their Situation is in the moſt convenient Place imaginable, for the Diſcharge of their Offices; at the firſt Entrance (c), in the Way to the grand Receptacle of our Food and Nouriſhment; to ſurvey what is to be admitted therein; to judge between what is wholſome, and fit for Nouriſhment, and what is unſavory and pernicious. And for this End, the all-wiſe Creator ſeems to have eſtabliſhed a great Conſent between the Eye, the Noſe, and Tongue, by ordering the Branches of the ſame Nerves (d), to each of thoſe three Parts; as alſo indeed, to divers other Parts of the Body, which I may have Occaſion to mention in a more proper Place (e). By which Means, there is alſo the Guard that can be, againſt

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menta ſunt. Quare obſervare eſt, Linguam præ aliâ quâvis parte inſigniter fibroſam eſſe, etiam texturâ valdè poroſâ conſtare, in eum nempe finem, ut particulæ rei ſapidæ copioſiùs ac penitiùs intra Senſorii meatus admittantur — Nervi autem qui fibris Linguæ denſiſſimè intertextis famulantur, ac ſaporum impreſſiones τῷ πρώτῳ αἰσθητηρίῳ communicant, ſunt — Nervi è paribus tum quinto, tum nono; & ubique cum denſâ propaginum ſerie per totam ejus compagem diſtributi. Willis ibid.

(c) *Guſtatus, qui ſentire eorum quibus veſcimur genera debet, habitat in eâ parte Oris, quâ eſculentis & poculentis iter natura patefecit.* Cic. de Nat. Deor. lib. ii. cap. 56. *Vide quoque ſupra*, Note (b) Chap. iv.

(d) *Multa hujus* [quinti Paris] *Nervi propagines Maſticationis operi deſtinantur; ideoque quoniam alimenta ingerenda non modò Guſtûs, aſt etiam Olfactûs & Viſûs examen ſubire debent, ab eodem Nervo, cujus rami ad Palatum & Fauces miſſi, Manducationis negotium peragunt, propagines aliæ, velut exploratrices, ad Nares & Oculos feruntur, nempe ut iſthæc aliorum ſenſuum organa, etiam ad objecta Guſtûs melius dignoſcenda probationum auxiliis quibuſdam inſtruantur.* Willis Nerv. Deſcrip. & Uſus, cap. 22.

(e) See *Book* V. *Chap.* viii.

pernicious Food; foraſmuch, as before it is taken into the Stomach, it is to undergo the Trial of three of the Senſes; the Scrutiny of the Eye, the ſtrict Surveyor of its outward Appearance; and the Probation of the Smell and Taſte, the two ſevereſt Judges of its natural Conſtitution and Compoſition.

CHAP. VI.

Of the Senſe of Feeling (a).

HAVING ſpent ſo much Time upon the other Senſes, and therein given ſuch ample Proofs of the infinite Creator's Wiſdom; I ſhall but briefly take Notice of two Things relating to this laſt Senſe.

(a) *Malpighi* is of Opinion, that as *Taſte* is performed by the *Papillæ* of the Tongue, ſo is *Feeling* by ſuch like *Papillæ* under the Skin. From ſeveral Diſſections, and other Obſervations, he thus concludes: *Ex his & ſimilibus videbatur animus abundè certior redditus, earundem Papillarum pyramidalium copiam, quas aliàs in Linguâ deſcripſi, in locis præcipuè acquiſitiori Tactui dicatis reperiri, eodem progigni nervoſo & cuticulari corpore, ſimulque circumvolvi reticulari involucro, & extimam cuticulam, veluti ultimum terminum, attingere.— Microſcopico quilibet in manûs dorſo pro ſudore orificia quædam miro ordine diſperſa intueri poteſt, circa quæ frequentia quædam capitula aſſurgunt; bæc verò ſunt Papillarum fines, dum à cute aſſurgentes interpoſitum ſuperant rete, ſimulque extimam cuticulam. Hæc repetitis ſectionibus deprebendi; ex quibus non improbabiliter deducam, ſicuti ex elatioribus — papillis — in Linguâ, Guſtûs Organon elicitur, — ita ex copioſâ barum Papillarum congerie — in organis, ubi maximè animalia Tactûs motione afficiuntur,—adæquatum Tactûs organum ſufficienter baberi.* Malpig. de extern. Tact. Organ. p. 26. *Conſul. quoque ejus Vit.* p. 28.

Theſe Obſervations of *Malpighi*, our late curious and diligent Mr. *Cowper* hath confirmed, and given us very elegant Cuts both of the Skin, and the *Papillæ*, and the Nerves, Glands, &c. under it, from Microſcopical Obſervations. *Vide Cowper's Anat. Introd.* and *Tab.* 4.

One is its Organ, and Nerves. For as all Senſation is performed by the Nerves *(b)*, and indeed the other Senſes (performed by Nerves) are a Kind of Feeling; ſo is this Senſe of *Feeling* performed by Nerves likewiſe, ſpread in the moſt incomparable, curious Manner throughout the whole Body. But to deſcribe their Origin in the Brain, and Spinal-Marrow, their Ramifications to all the Parts; their Inoſculations with one Another; and other Matters; whereby not only the Senſe of *Feeling* is performed, but alſo animal Motion, and admirable Conſent and Harmony of all the Parts of the Body is effected: (To deſcribe, I ſay, theſe Things,) would take up too much Time, and I have already, and ſhall, as I go along, give ſome Hints thereof.

The other Thing I ſhall take Notice of, is, the Diſperſion of this Senſe throughout the Body, both without and within. The other Senſes, I have obſerv'd, are ſeated in the very beſt Place for the Relief and Comfort, the Guard and Benefit of the Animal. And foraſmuch as it is neceſſary to the Being, and Well-being of the Body, that every Part ſhould be ſenſible of Things ſafe, or Things prejudicial to itſelf; therefore, it is an admirable Contrivance of the great Creator, to diſperſe this Senſe of *Feeling* throughout every Part *(c)*; to diſtinguiſh between

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(b) Although the Eye be the uſual Judge of Colours, yet ſome have been able to diſtinguiſh them by their Feeling. *Quidam fuit qui venit ad M. Duc.* Hetruriæ *aulam, qui colores per Tactum cognoſcebat. Pro experimento velum ſericam, uniformiter textum, & pluribus coloribus tinctum, offerebatur; & veracitèr de colore in ſingulis partibus judicabat.* Grimald. de Lum. & Col. prop. 43. ſect. 59.

(c) Tactus autem toto corpore equabilitèr fuſus eſt, ut omnes ictus, omneſque nimios & frigoris & caloris appulſus, ſentire poſſimus. Cic. *ubi ſupra.*

between Pleaſure and Pain; Things ſalutary, and Things hurtful to the Body.

Thus in the five Senſes of Animals, we have an OEconomy worthy of the Creator, and manifeſtly demonſtrating his Power, Wiſdom, and Indulgence. For whether we conſider the Mechaniſm of the Organs, or the great Uſe and Convenience of each Senſe, we find it noble and grand, curious and artificial; and every Way worthy of its infinite Maker, and beyond the Wit and Power of any Thing but a GOD: And therefore we muſt even deny our Senſes, by denying them to be God's Handywork.

And now from thoſe chief Machines of Animal Performances and Enjoyments, the five Senſes; let us paſs to another Thing in common to all the ſenſitive Creatures, which is Reſpiration.

Tactus ſenſus omnibus eſt, etiam quibus nullus alius; nam & Oſtreis, & terreſtribus Vermibus quoque. Exiſtimaverim omnibus ſenſum & Guſtatûs eſſe. Cur enim alios alia ſapores appetunt? in quo vel præcipua Naturæ architectio. Plin. Nat. Hiſt. lib. x. cap. 71.

CHAP.

CHAP. VII.

Of Reſpiration.

OF all the Acts of Animal Life, this is one of the chief, and moſt neceſſary. For whatſoever hath Animal Life, hath alſo the Faculty of Reſpiration, or ſomewhat equivalent thereto *(a)*. Indeed

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(a) The Uſes aſſigned to *Reſpiration* by all the Anatomiſts before *Malpighi*'s Diſcoveries of the Structure of the Lungs, are ſo various, and many of them ſo improbable, that it would be frivolous to recount them. But the more eminent modern Anatomiſts aſſign theſe Uſes. *Willis* thus ſums up his Opinion: *Præcipua Pulmonum functio, & uſus ſunt, ſanguinem & aërem per totas partium compages, intimoſque receſſus, atque ductus quoſque minutiſſimos traducere, & ubique invicem committere; in eum nempe finem, ut ſanguis venoſus à circuitu redux, & chymo recenti dilutus—tum perfectiùs miſceatur & velut ſubigatur, tum potiſſimùm ut ſecundùm omnes ſuas partes ab aëre nitroſo de novo accendatur.* Pharmaceut. p. ii. ſect. 1. cap. 2. ſect. 2. *Mayow* ſaith rightly, that one grand Uſe of *Expiration* is, *Ut cum aëre expulſo, etiam vapores è ſanguine exhalentes, ſimul exſufflentur.* And as for *Inſpiration*, that it conveyeth a nitro-aerial Ferment to the Blood, to which the Animal Spirits are owing, and all Muſcular Motion. *Mayow de Reſpir.* p. 22, *&c. meâ Edit.*

Somewhat of the Opinion of theſe two laſt cited, if I miſtake not (it being long ſince I read their Tracts, and have them not now at hand), were *Ent*, *Sylvius*, *Swammerdam*, *Diemerbroeck*, and my Friend Mr. *Ray*, in an unpubliſhed Tract of his, and his Letters now in my Hands.

But our Dr. *Thurſton*, for good Reaſons, rejects theſe from being principal Uſes of *Reſpiration*, and thinks, with great Reaſon, the principal Uſe to be, to move, or paſs the Blood from the right to the left Ventricle of the Heart. Upon which account Perſons hanged, drowned, or ſtrangled by Catarrhs, deed ſo congenial is this with Life, that *Breath* and *Life* are in Scripture Phraſe and Common Speech

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ſo ſuddenly die, namely, becauſe the Circulation of their Blood is ſtopped. For the ſame Reaſon alſo it is, that Animals die ſo ſoon in the Air-Pump. Among other Proofs, he inſtanceth in an Experiment of Dr. *Croon*, *Profeſſ. Greſh.* which he made before our *Royal Society*, by ſtrangling a Pullet, ſo that not the leaſt Sign of Life appeared; but by blowing Wind into the Lungs through the *Trachea*, and ſo ſetting the Lungs a-playing, he brought the Bird to Life again. Another Experiment was once tried by Dr. *Walter Needham*, before Mr. *Boyle* and others, at *Oxford*, by hanging a Dog, ſo that the Heart ceaſed moving. But haſtily opening the Dog, and blowing Wind into the *Ductus Pecquetianus*, he put the Blood in Motion, and by that Means the Heart, and ſo recovered the Dog to Life again. *Vide Thurſton de Reſpir. Uſ.* p. 60, 63, *meâ Edit.*

Such an Experiment as Dr. *Croon*'s, my Friend the late juſtly renowned Dr. *Hook* ſhewed alſo our *Royal Society*. He cut away the *Ribs*, *Diaphragm*, and *Pericardium*, of a Dog; alſo the Top of the Wind-Pipe, that he might tie it on to the Noſe of a Pair of Bellows; and by blowing it into the Lungs, he reſtored the Dog to Life; and then ceaſing blowing, the Dog would ſoon fall into dying Fits; but by blowing again, he recovered; and ſo alternately would die, and recover, for a conſiderable Time, as long and often as they pleaſed. *Phil. Tranſ.* N° 28.

For the farther Confirmation of Dr. *Thurſton*'s Opinion, the ingenious Dr. *Muſgrave* cut off, and cloſe ſtopped up the Wind-Pipe of a Dog with a Cork, and then threw open the *Thorax*; where he found the Blood ſtagnating in the *Lungs*, the *Arteria Pulmonaris*, the *Right Ventricle*, and *Auricle* of the *Heart*, and the two great Trunks of the *Cava*, diſtended with Blood to an immenſe Degree; but, at the ſame Time, the *Vena Pulmonaris*, the *Left Ventricle* and *Auricle* of the *Heart* in a manner empty, hardly a Spoonful of Blood therein. *Philoſ. Tranſ.* N° 240. Or both the Experiments may be together met with *Lowth. Abridg.* vol. iii. p. 66, 67.

This Opinion of our learned *Thurſton*, the late learned *Ettmullerus* eſpouſed, who being particular in reckoning up the Uſes of Reſpiration, I ſhall therefore the more largely cite him. Reſpiration, ſaith he, ſerves, 1. *Ad Olfactum.* 2. *Ad Screatum & Sputationem.* 3. *Ad Oſcitationem, Tuſſim, Sternutationem, Emunctionemque.* 4. *Ad liquidorum Sorbitionem, Suctionemve.* 5. *Ad Loquelam, Cantum, Clamorem, Riſum, Fletum, Flatum, &c.* 6. *Ad fæcum Alvi, Urinæ, Fœtûs Molæve, nec-*

non

Speech taken as ſynonymous Things, or at leaſt, neceſſary Concomitants of one another. *Moſes*

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non Secundinarum expulſionem. 7. *Ad promovendi Ventriculi, Inteſtinorum, Lacteorumque vaſorum, &c. contenta.* 8. *Ad halitus aqueos Sanguinis è pulmonibus, aëris ope, exportandos.* 9. *Ad Diapnoën.* 10. *Ad exactiorem Chyli, Lymphæque, necnon Sanguinis — miſcelam.* 11. *Ad conciliandum ſanguini — coccineam rubedinem, &c.* 12. *Nec moroſè negabimus, aërem — pulmones, & ſanguinem illos tranſcurrentem, minùs calida reddere, &c.* 13. *Quòd denique aër ſanguini ſingulis Reſpirationibus aliquantillâ ſui parte, admixtus, pauciſſimas quaſdam in ſpirituum animalium elaboratione particulas ſimul contribuat.* All theſe Uſes, although of great Conſequence, yet he thinks rather conduce to the *Well Being*, than the Being of the Animal; becauſe without any of them, the Animal would not ſo ſpeedily die, as it doth by Strangling, or in the Air-Pump. He therefore aſſigns a 14th, and the principal Uſe of Reſpiration to be, *For the paſſing of the Blood through the Lungs, that is thrown into them by the Heart.* Etmull. Diſſer. ii. cap. 10. ſect. 1. and 16.

But the late Dr. *Drake*, with great Ingenuity and Addreſs, (like a Perſon ſo conſiderable for his Years, as he was in his Time,) not only eſtabliſhed this Notion of Reſpiration, but alſo carries it farther, making it the true Cauſe of the *Diaſtole* of the Heart; which neither *Borelli*, *Lower*, or *Cowper*, much leſs any before thoſe great Men, have well accounted for. That the Heart is a Muſcle, is made evident beyond all doubt, by Dr. *Lower*. And that the Motion of all Muſcles conſiſts in Conſtriction, is not to be doubted alſo. By which Means the *Syſtole* is eaſily accounted for. But foraſmuch as the Heart hath no *Antagoniſt-Muſcle*, the *Diaſtole* hath puzzled the greateſt Wits. But Dr. *Drake*, with great Judgment, and much Probability of Reaſon, maketh the Weight of the incumbent Atmoſphere be the true *Antagoniſt* to all the Muſcles, which ſerve both for ordinary Inſpiration, and the Conſtriction of the Heart. The Particulars of his Opinion may be ſeen in his *Anatomy*, lib. ii. cap. 7. And in *Philoſ. Tranſ.* N° 281.

And I remember when I was at the Univerſity, my moſt ingenious and learned Tutor, Dr. *Wills*, when he read Anatomy to us, was of Opinion, That the Lungs were blown up by the Weight of the incumbent Air, and repreſented the Manner of Reſpiration in this Manner, *viz.* He put a Bladder into a Pair of Bellows, turning back the Neck of the Bladder, and tying it faſt, ſo that no Air might enter in between the Bladder and Bellows. This being done, when the Bellows were opened, the Bladder would be blown up by the Weight of the incum-ſes (b) expreſſeth Animal-Life, by [*The Breath of Life.*] Saith he, *Gen.* vii. 21, 22. *All Fleſh that moveth on the Earth, Fowl, Cattle, Beaſt, creeping Things, and Man; all in whoſe Noſtrils was the Breath of Life in the dry Land died.* So the Pſalmiſt, *Pſal.* civ. 29. *Thou takeſt away their Breath, they die.* So grand an Act therefore in common to all Animals, may juſtly deſerve a Place in this Survey of the Works of God in the Animal-Kingdom.

And here I might launch out into an ample Deſcription of all the Parts miniſtring to this neceſſary Act, and ſhew the curious Contrivance, and artificial Structure of them; but a tranſient View ſhall ſuffice. I might begin with the outward Guards, the Noſe and Mouth; but theſe have been already touched upon. But the exquiſite Mechaniſm of the *Larynx*, its Variety of Muſcles, its Cartilages, all ſo exquiſitely made for the Purpoſe of Reſpiration, and forming the Voice (c), are very admirable: and no

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incumbent Air; and when ſhut, the Air would be thereby paſſed forcibly out of the Bladder, ſo as to blow the Fire. This Experiment I take Notice of here, becauſe (beſides the Illuſtration it gives to Reſpiration) that great *Genius* ſeems to have had a truer Notion of this *Phænomenon*, than was very common then, *viz.* about the Year 1677, or 78; as alſo, becauſe I have in ſome Authors met with the ſame Experiment, without Mention of Dr. *Wills*, whoſe I take it to have been.

Another Uſe of great Conſideration, the already commended Dr. *Cheyne* aſſigns; namely, to Form the Elaſtick Globules of which the Blood principally conſiſts, without which there would be a general Obſtruction in all the capillary Arteries. *Cheyne's Philoſophical Principles of Natural Religion*; or *Harris's Lex. Tech.* in *Lungs.*

(b) *Gen.* ii. 7, — vi. 17. and vii. 15.

(c) Becauſe it would be endleſs to ſpecify the curious Mechaniſm of all the Parts concurring to the Formation of the Voice; I ſhall therefore, for a Sample, note only two Things: 1. There are thirteen Muſcles provided for the Motion of the five Cartilages of the *Larynx*, *Gibſ. Anat.* lib. ii. cap. 14. a Sign of the careful and elaborate Proviſion that is made for the no leſs ſo is the Tongue *(d)*, which miniſters to that, and many other Uſes too.

Next, the Fabrick of the *(e) Trachea* deſerves eſpecial Remark. Its Valve, the *Epiglottis* on the Top,

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the Voice. 2. It is a prodigious Faculty of the *Glottis*, in contracting and dilating itſelf with ſuch Exquiſiteneſs as to Form all Notes. *For* (as the ingenious Dr. *Keil* ſaith,) *ſuppoſing the greateſt Diſtance of the two Sides of the* Glottis, *to be one tenth Part of an Inch in ſounding twelve Notes, (to which the Voice eaſily reaches;) this Line muſt be divided into twelve Parts, each of which gives the Aperture requiſite for ſuch a Note, with a certain Strength. But if we conſider the Sub-diviſion of Notes, into which the Voice can run, the Motion of the Sides of the* Glottis *is ſtill vaſtly nicer. For if two Chords ſounding exactly Uniſons, one be ſhortened one two thouſandth Part of its Length, a juſt Ear will perceive the Diſagreement, and a good Voice will ſound the Difference, which is one hundred and ninety-ſixth Part of a Note. But ſuppoſe the Voice can divide a Note into a hundred Parts, it follows that the different Apertures of the* Glottis *actually divide the tenth Part of an Inch into twelve hundred Parts, the Effect of each of which produces a ſenſible Alteration upon a good Ear. But becauſe each Side of the* Glottis *moves juſt equally, therefore the Diviſions are juſt double; or the Sides of the* Glottis, *by their Motion, do actually divide one tenth Part of an Inch into two thouſand four hundred Parts.* Keil's Anat. cap. iii. ſect. 7.

(d) Among the Inſtruments of Speech, the Tongue is a neceſſary one; and ſo neceſſary, that it is generally thought no Speech can be without it. But in the third Tome of the *Ephem. Germ.* is publiſhed, *Jac. Rolandi Agloſſoſtomographia, ſive Deſcriptio Oris ſine Linguâ quod perfectè loquitur, & reliquas ſuas functiones naturaliter exercet.* The Perſon deſcribed is one *Pet. Durand*, a *French* Boy, of eight or nine Years old, who, at five or ſix, loſt his Tongue by a *Gangrene*, occaſioned by the Small-Pox: Notwithſtanding which, he could (as the Title ſaith) ſpeak perfectly, as alſo taſte, ſpit, ſwallow, and chew his Food; but this latter he could do only on that Side he put it into, not being able to turn it to the other Side of his Mouth.

In the ſame Tract, *Chap.* 6. is this Obſervation of *Ventriloquous* Perſons: *Memini me à quodam ſat celebri Anatomico audiviſſe, dum de duplicaturâ Mediaſtini ageret, ſi Membrana iſta duplex naturalitèr unita in duas partes dividatur, loquelam quaſi ex pectore procedere, ut circumſtantes credant Dæmoniacum hunc, aut Sternomythum.*

(e) The Variation of the Wind-Pipe is obſervable in every Creature, according as it is neceſſary for that of the Voice. In an Urchin,

Top, to fence againſt all Annoyances; its cartilaginous Rings (*f*) nearly environing it, with its membranous Part next the Gullet, to give the freer Paſſage to the Deſcent of the Food; and laſtly, its inner Tegument, of exquiſite Senſe, to be readily affected with, and to make Efforts againſt every thing that is hurtful or offenſive; theſe, I ſay, do all juſtly deſerve our Admiration.

And no leſs prodigious are the Parts farther within; the *Bronchi*, the *Veſiculæ* (*g*), with their muſcular

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Urchin, *which hath a very ſmall Voice, it is hardly more than membranous: And in a* Pigeon, *which hath a low and ſoft Note, it is partly cartilaginous, and partly membranous. In an* Owl, *which hath a good audible Note, it is more cartilaginous; but that of a* Jay *hath hard Bones inſtead of Cartilages; and ſo of a* Linnet: *Whereby they have both of them a louder and ſtronger Note,* &c.

The Rings of the Wind-Pipe are fitted for the Modulation of the Voice: For in Dogs *and* Cats, *which, in the Expreſſion of divers Paſſions, uſe a great many Notes (as Men do), they are open and flexible, as in Man. Whereby all, or any of them, are dilated or contracted, more or leſs, as is convenient for a higher or deeper Note,* &c. *whereas in ſome other Animals, as in the* Japan Peacock, *which uſeth hardly more than one ſingle Note, they are entire,* &c. Grew's Coſmolog. Sacr. book I. chap. v. ſect. 9, 10.

(*f*) It is a farther manifeſt Indication of ſingular Deſign in the cartilaginous Rings of the *Aſpera Arteria*, that all the Way where they are contiguous to the *Oeſophagus*, they are membranous, to afford an eaſy Paſſage to the Food; but after that, in the *Bronchi*, they are, ſome completely angular, ſome triangular, *&c.* And another Obſervable is, the lower Parts of the ſuperior Cartilages receive the upper Parts of the inferior in the *Bronchi*; whereas in the *Aſpera Arteria*, the Cartilages run and remain parallel to one another; which is a noble Difference or Mechaniſm in this (in a Manner) one and the ſame Part, enabling the Lungs, and *Bronchi*, to contract themſelves in Expiration, and to extend and dilate themſelves in Inſpiration.

(*g*) I ſhall not here intrench ſo much upon the Anatomiſt's Province, to give a Deſcription of the *Lungs*, although it be a curious Piece of God's Workmanſhip; but refer to Signior *Malpighi*, lar Fibres *(b)*, as ſome aſſert they have, together with the Arteries and Veins, which every where accompany the airy Paſſages, for the Blood to receive there its Impregnations from the Air.

From

Malpighi, the firſt Diſcoverer of their *Veſiculæ* in 1660, in his two Letters to *Borelli, de Pulmon.* Alſo to Dr. *Willis*'s *Pharm. rat.* p. 2. ſect. i. cap. i. *de Reſpir. Orig. & Uſ.* who as he wrote after *Malpighi*, ſo hath more accurately deſcribed thoſe Parts; and to Mr. *Cowper*'s *Anat. Tab.* 24, 25. And if the Reader hath a Mind to ſee what Oppoſition Signior *Malpighi*'s Diſcoveries met with at Home and Abroad, and what Controverſies he had on that Account; as alſo his Cenſures of Dr. *Willis*'s Deſcription and Figures, he may conſult *Malpighi*'s Life, written by himſelf, p. 4 to 21.

That the *Lungs* conſiſt of *Veſiculæ*, or *Lobuli* of *Veſiculæ*, admitting of Air from the *Bronchi*, is viſible, becauſe they may be blown up, cleanſed of Blood, and ſo dried. But Mr. *Cowper* ſaith, he could never part the *Lobuli*, (ſo as to make Dr. *Willis*'s *Fig.* 1. *Tab.* 3. & 4.) ſo that probably the *Veſiculæ* are contiguous to one another throughout each Lobe of the Lungs. And not only Air, but *Diemerbroeck* proves, That the *Veſiculæ* admit of Duſt alſo, from two Aſthmatick Perſons he opened; one a Stone-cutter's Man, the *Veſiculæ* of whoſe Lungs were ſo ſtuffed with Duſt, that in cutting, his Knife went as if through an Heap of Sand; the other was a Feather-Driver, who had theſe Bladders filled with the fine Duſt or Down of Feathers.

(b) There is a conſiderable Difference between Dr. *Willis* and *Etmuller*, *viz.* Whether the *Veſiculæ* of the Lungs have any muſcular Fibres, or not? *Etmuller* expreſly ſaith, *Nullas Fibras muſculoſas, multo minus rubicundum Muſculorum compagem (ſunt enim Veſiculæ albidæ & fere diaphanæ) in ipſis reperiri.* Ubi ſupra, cap. vi. ſect. 2. And afterwards, ſect. 3. *Pulmones eſſe molles flexileſque muſculoſis fibris ceu propriæ explicationis organis deſtitutos.* But Dr. *Willis* as expreſly aſſerts they have muſculous Fibres, and aſſigns an excellent Uſe of them: *Cellulæ iſtæ veſiculares, ut nixus pro expiratione contractivos edant, etiam fibras, uti per Microſcopium planè conſpicere eſt, muſculares obtinent.* Ubi ſupra, ſect. 16. And in the next Section, *Ut pro datâ occaſione majorem aëris copiam exſufflent, aut materiam extuſſiendam ejiciant, fibris muſcularibus donatæ, ſeſe arctiùs contrahunt, contentàque ſua penitùs exterminant. Et enim ordinariæ pectoris Syſtolæ, quas muſculorum relaxationes ex parte efficiunt, aërem forſan totum à Tracheâ & Bronchiis, haud tamen à Veſiculis, quâ-*

From hence I might proceed to the commodious Form of the Ribs *(i)*, the curious Mechaniſm of the Intercoſtal-Muſcles *(k)*, the Diaphragm, and all the other Muſcles *(l)*, miniſtring both to the ordinary, and extraordinary Offices of Reſpiration. But

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que vice ejiciunt: propter has (quoties opus erit) inaniendas, & totius Pectoris cavitas plurimùm anguſtatur, & cellulæ ipſæ veſiculares à propriis fibris conſtrictis coarctantur.

(i) Circa hos motus [ſcil. Pectoris dilationem, &c.] divini Conditoris mechanicen, ad regulas Mathematicas planè adaptam, ſatis admirari non poſſumus; ſiquidem nullâ aliâ in re manifeſtiùs. Ὁ Θεὸς γεωμετρεῖν *videtur. Quippe cùm pectoris, tum ampliatio, tum coarctatio à quibuſdam Muſculis (quorum munus unicum eſt contrahere) perfici debeat; res ita inſtituitur, ut Coſtæ quæ thoracis, velut parallelogrammi oblongi verſus cylindrum incurvati, latera efformant, in figuram modò quadratam, cum angulis rectis, pro pectoris ampliatione; modò in rhomboeidem, cum angulis acutis pro ejuſdem contractione, ducantur, &c.* Willis, ubi ſupra, ſect. 28.

Galen having ſpoken of the Parts miniſtering to Reſpiration, concludeth, *Nihil uſquam à Naturâ ullo pacto per incuriam, fuiſſe præteritum, quæ cùm omnia præſentiret & provideret, quæ ſunt neceſſaria illa, quæ cauſa alicujus extiterunt, conſecutura, omnibus inſtaurationes parare occupavit, cujus apparatus copioſa facultas admirabilem Sapientiam teſtantur.* De Uſ. Part. lib. v. cap. 15. See alſo lib. vi. cap. 1.

(k) For the Structure of the *Intercoſtals, Midriff*, &c. I ſhall refer to Dr. *Willis* and other Anatomiſts. But Dr. *Drake* taxeth Dr. *Willis* with an Error, in fancying there is an Oppoſition in the Office of the *Intercoſtals*, by Reaſon that the Fibres of the *external* and *internal Intercoſtals* decuſſate; that therefore the *external* ſerve to raiſe the Ribs, the *internal* to draw them down. But Dr. *Drake* is of *Steno*'s and Dr. *Mayow*'s Opinion, That, notwithſtanding the Decuſſation of their Fibres, the Power they exert upon, and the Motion they exert in the Ribs, is one and the ſame. *Drake's Anat.* lib. ii. cap. 7. and lib. iv, cap. 5. *Mayow de Reſp.* cap. 7.

(l) Although Dr. *Drake*, and ſome others, deny the *Intercoſtals* being Antagoniſt-Muſcles, as in the preceding Note; yet they, and moſt other Anatomiſts that I have met with, attribute a conſiderable Power to them in the Act of Reſpiration, as they do alſo to the *Subclavian* and *Triangular-Muſcles*; but the learned *Etmuller* denies it for theſe three Reaſons: 1. *Quia reſpirando nullam in illis contractionem ſentio.* 2. *Quia — ſibi invicem non adducuntur, &c.* 3. *Quia Coſtæ omnes ab aliis modò enarratis*

But paſſing them by, I ſhall ſtop at one prodigious Work of Nature, and manifeſt Contrivance of the Almighty Creator, which although taken Notice of by others *(m)*, yet cannot be eaſily paſſed by in the Subject I am upon; and that is the Circulation of the Blood in the *Fœtus in the Womb*, ſo different from the Method thereof after it is Born. In the Womb, whilſt it is as one Body with the Mother, and there is no Occaſion, nor Place for Reſpiration, there are two Paſſages *(n)* on Purpoſe for the Tranſmiſſion of the Blood without paſſing it through the Lungs.

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enarratis muſculis moventur, idque ſimul, &c. Intercoſtales itaque, necnon Subclavios Muſculos Coſtis, parietum inſtar, ad complenda interſtitia intercoſtalia, pectuſque integrandum, ac Coſtas connectendas, intertectos eſſe, probabiliter concludo; quo munere triangulares etiam — fungi, rationi conſentaneum eſt. Etmul. Diſſert. ii. cap. 4. ſect. 6.

But as to the Uſe of the *Triangular-Muſcle* in Reſpiration, we may judge of it, from its remarkable Size and Uſe in a Dog; of which Dr. *Willis* gives this Account from *Fallopius*: *In Homine parvus adeò & ſubtilis iſte* [Muſculus] *eſt, ut vix pro Muſculo accipi queat: in Cane per totum os pectoris protenditur, & cartilagines omnes, etiam verarum Coſtarum ſterno inoſculatas, occupat: Cujus diſcriminis ratio divinam circa Animalium fabricas Providentiam planè indigitat. Quippe cùm hoc animal, ad curſus velociſſimos & diu continuandos natum, quos ſanguis, dum intenſiùs agitatur, ritè accendatur eventileturque, aërem celerrimè & fortiter uti inſpirare, ita etiam exſpirare debet — idcirco propter hunc actum firmiùs obeundum (cujus in Homine haud magnus eſt uſus) muſculus caninus molem ingentem & tanto operi parem ſortitur.* Willis, ubi ſupra, ſect. 32.

(m) Ray's *Wiſdom of God in the Creation*, p. 343.

(n) Mr. *Cheſelden*, an ingenious and moſt accurate Anatomiſt, having ſomewhat Particular in his Obſervations about the Circulation of the Blood through the Heart of the *Fœtus*, I ſhall preſent the Reader with ſome of his Obſervations, which he favoured me with the Sight of. *The Blood* (ſaith he) *which is brought to the Heart by the aſcending* Cava, *paſſes out of the Right Auricle into the Left, through a Paſſage called* Foramen Ovale, *in the* Septum [common to them both] *without paſſing through the right Ventricle (as after the Birth) while the Blood from the deſcending* Cava *paſſeth through the Right Auricle and*

Lungs. But as ſoon as the *Fœtus* is born, and become thereby a perfectly diſtinct Being, and breathes for itſelf, then theſe two Paſſages are ſhut up; one nearly obliterated, the other becomes only a Ligament, except in ſome Creatures that are Amphibious, or are forced to lie long under Water, in whom theſe Paſſages probably remain open (*o*).

And now what Action of any rational Creature, what is there in a Man's Life, that doth more plainly

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Ventricle into the Pulmonary Artery, and thence into the Aorta *through the Duct, betwixt that and the Pulmonary Artery, called* Ductus Arterioſus, *whilſt a ſmall Portion of the Blood, thrown into the Pulmonary Artery, paſſeth through the Lungs, no more than is ſufficient to keep open the Pulmonary Veſſels. Thus both Ventricles are employed in driving the Blood through the* Aorta *to all Parts of the* Fœtus, *and to the Mother too. But after the Birth, the Blood being to be driven from the* Aorta *through the* Fœtus *alone, and not the Mother too, one Ventricle becomes ſufficient, whilſt the other is employed in driving the Blood through the Lungs, the* Ductus Arterioſus *being ſhut up by Means of the Alteration of its Poſition, which happens to it from the raiſing of the* Aorta *by the Lungs, when they become inflated. After that the Blood is thus driven into the Lungs, in its Return it ſhuts the* Valve *of the* Foramen Ovale *againſt the* Foramen *itſelf, to whoſe Sides it ſoon adheres, and ſo ſtops up the Paſſage. The* Ductus Arterioſus, *or* Ductus Arterioſus in Ligamentum verſus, *is ſeldom to be diſcerned in adult Bodies, but the Figure of the* Foramen Ovale *is never obliterated.*

(*o*) It hath been generally thought not to be improbable, but that on ſome Occaſion the *Foramen Ovale* may remain open in Man. In a Girl of four or five Years of Age, Dr. *Connor* found it but half cloſed, and in the Form of a Creſcent. And he thinks that ſomewhat of this Kind might be in the Perſon whoſe Skeleton was found to have no Joints in the Back Bone, Ribs, *&c.* Of which a Deſcription, with Cuts, may be found in *Phil. Tranſ.* N° 215. And more largely in his *Diſſert. Med. Phyſ. de ſtupendo Oſſium coalitu*, where he adds to the Girl, in whom the *Foramen Ovale* was not ſhut, a like Obſervation of another Girl he opened at *Oxford*, of three Years Old; *In quâ Foramen Ovale ferè erat occluſum, in medio tamen, exili foramine, per quod Turundam facilè tranſmiſi, erat* plainly ſhew Deſign, Reaſon, and Contrivance, than this very Act of Nature doth the Contrivance and

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orâ pervium, p. 30. So Mr. *Cowper* (than whom none more accurate and better Judge) ſaith, *I have often found the* Foramen Ovale *open in the Adult.* Anat. Append. Fig. 3. But Mr. *Cheſelden* is of a different Opinion, of which in the following Note:

From ſomewhat of this Cauſe, I am apt to think it was that the *Tronningholm* Gardener eſcaped drowning, and ſome others, mentioned by *Pechlin*. His Stories are, *Hortulanus Tronningholmenſis etiamnum vivens, annos natus* 65, *pro illâ ætate ſatis adhuc valens & vegetus, cùm ante* 18 *annos, alii in aquas delapſo opem ferre vellet, forte fortunâ & ipſe per glaciem incautiùs procedens, aquas incidit* 18 *ulnas profundas: ubi ille, corpore erecto quaſi ad perpendiculum, pedibus fundo adhæſit. Conſtitit ſic per* 16 *horas, antequàm produceretur in auras. Dixit autem, ſimul ac infra aquarum ſuperficiem fuit demerſus, ſtatim obriguiſſe totum, &, ſi quem tum habuit motum & ſenſum, amiſiſſe, niſi quod ſonantes Stocholmii campanas etiam ſub aquis obſcurius percipere ſibi ſit viſus. Senſit etiam, ſtatim ſeſe velut veſiculam ori applicâſſe, adeò ut aqua nulla os penetraverit, in aures verò tranſitum, etiam ſentiente illo, habuerit; atque inde auditum ſuum debilitatum aliquandiu eſſe. Hoc ſtatu dum* 16 *horas permanſit fruſtrà quæſitus tandem repertum, conto in caput infixo, cujus etiam ſenſum ſe habuiſſe dixit, fundo extraxerunt, ſperantes ex more aut perſuaſione gentis revicturum eſſe. Itaque pannis linteiſque productum obvolvunt, ne aëre admitti poſſit pernicioſus futurus ſubito illapſu: cuſtoditum ſic ſatis ab aëre ſenſim ſenſimque tepidiori loco admovent mox calidis adoriuntur faſciis, fricant, radunt, & ſufflaminatum, tot horis ſanguinis corporiſque motum negotioſâ illâ opera reducunt: denique antapoplecticis & genialibus liquoribus vitæ reddunt & priſtinæ mobilitati. Retulit is atque oſtendit ſe etiamnum in capite circumferre veſtigia violentiæ à conto illatæ, & cephalalgiis vexari graviſſimis. Et propter hunc ipſum caſum, religiosè à popularibus, & hujuſce rei teſtibus probatum, Sereniſſimæ Reginæ matris munificentiâ & annuo ſtipendio eſt donatus — & Sereniſ. Principi — oblatus vivus ſui teſtis — Conſignatam manu habes Hiſtoriam D. Tilaſii, Biblioth. Reg. Præfecti, qui teſtatus eſt ſe prænoviſſe mulierem, quæ tres ipſos dies ſub aquis hæſit, & ſimilem in modum, quo Hortulanus ille, reſuſcitata, adhuc dum lucis plenâ fruitur uſurâ. Accedit Nob. Burmanni — fides, qui confeſſus eſt, — ſe in pago* Boneſs *parochiæ* Pithoviæ *concionem frequentâſſe funebrem, in quâ, dum acta*

and Deſign of the great God of Nature? What is Thought and Contrivance, if this be not? Namely, That there ſhould be a temporary Part in the Body, made juſt for the preſent Exigence; to continue whilſt there is Occaſion for it, and to ceaſe when there is none; in ſome Creatures to remain always, by Reaſon of their amphibious Way of Living, and in Land-Animals (purely ſuch) to ceaſe.

Another excellent Contrivance, a-kin to the laſt, is, for the Preſervation of ſuch Creatures whoſe Occaſions frequently neceſſitate them to live with-

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acta recenſeret Præco Senis cujuſdam ſeptuagenarii Laur. Jonæ — *audiverit ex ore Concionatoris, vivum eum, adoleſcentem* 17 *annorum, aquis ſubmerſum,* 7 *demum hebdomadâ (rem prodigioſam!) extractum ad ſe rediiſſe vivum & incolumem.* Pechlin. de Aer. & Alim. def. cap. 10.

Shall we to this Cauſe, or to the Oſſification, or more than ordinary Strength of the Wind-Pipe, attribute the Recovery to Life of Perſons hanged? Of which *Pechlin* gives an Inſtance that fell under his own Knowledge, of a Woman hanged, and in all appearance dead, but recovered by a Phyſician accidentally coming in, with a plentiful Adminiſtration of *Spir. Sal. Armon.* Pechl. ib. cap. 7. And the Story of *Anne Green,* executed at *Oxford, December* 14, 1650, is ſtill remembered among the Seniors there. *She was hanged by the Neck near half an Hour, ſome of her Friends in the mean Time thumping her on the Breaſt, others hanging with all their Weight upon her Legs, ſometimes lifting her up, and then pulling her down again with a ſudden Jerk, thereby the ſooner to diſpatch her out of her Pain;* as her printed Account wordeth it. After ſhe was in her Coffin, being obſerved to breathe, a luſty Fellow ſtamped with all his Force on her Breaſt and Stomach, to put her out of her Pain. But by the Aſſiſtance of Dr. *Peity,* Dr. *Willis,* Dr. *Bathurſt,* and Dr. *Clark,* ſhe was again brought to Life. I myſelf ſaw her many Years after, after that ſhe had (I heard) borne divers Children. The Particulars of her Crime, Execution, and Reſtauration, ſee in a little Pamphlet, called *News from the Dead,* written, as I have been informed, by Dr. *Bathurſt* (afterwards the moſt vigilant and learned Preſident of *Trinity College, Oxon),* and publiſhed in 1651, with Verſes upon the Occaſion.

out, or with but little Reſpiration: Fiſhes might be named here, whoſe Habitation is always in the Waters; but theſe belong to an Element which I cannot at preſent engage in. But there are many Animals of our own Element, or partly ſo, whoſe Organs of Reſpiration, whoſe Blood, whoſe Heart, and other Inſtruments of Life, are admirably accommodated to their Method of Living: Thus many amphibious Creatures (p), who live in Water as well as in Air; many Quadrupeds, Birds, Inſects, and other Animals who can live ſome Hours, Days, yea, whole Winters, with little or no Reſpiration, in a Torpitude, or ſort of Sleep, or middle State between Life and Death: The Proviſion made for theſe peculiar Occaſions of Life, in the Fabrick of the Lungs, the Heart, and other Parts of ſuch Creatures (q), is ma-

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(p) The *Sea-Calf* hath the *Foramen Ovale*, by which Means it is enabled to ſtay long under the Water, as the *Pariſ. Anatomiſts*. Of which ſee in *Book* VI. *Chap*. v. *Note (e)*.

But the fore-commended Mr. *Cheſelden* thinks the *Foramen Ovale* is neither open in amphibious Creatures, nor any adult Land-Animals. *When I firſt* (ſaith he) *applied myſelf to the Diſſection of human Bodies, I had no Diſtruſt of the frequent Accounts of the* Foramen Ovale *being open in Adults; but I find ſince, that I miſtook the* Oſtium Venarum Coronariarum *for the* Foramen. *The like I ſuppoſe Authors have done, who aſſert that it is always open in amphibious Animals; for we have made diligent Enquiry into thoſe Animals, and never found it open. Neither would that (as they imagine) ſerve theſe Creatures to live under Water, as the* Fœtus *doth in* Utero, *unleſs the* Ductus Arterioſus *was open alſo.*

This Opinion of Mr. *Cheſelden* hath this to render it probable, That the *Oſtium Venarum Coronariarum* is ſo near the *Foramen Ovale*, that without due Regard, it may be eaſily miſtaken for it. Such therefore as have Opportunity of examining this Part in amphibious Animals, or any other Subject, ought to ſeek for the *Oſtium*, whenever they ſuſpect they have met with the *Foramen*.

(q) Of the ſingular Conformation of the Heart and Lungs of the *Tortoiſe*, which is an amphibious Animal, ſee *Book* VI. *Chap*. v. *Note (b)*.

nifeſtly

niſeſtly the Work of him, who, as St. *Paul* ſaith (r), *Giveth to all Breath, and Life, and all Things.*

(r) *Acts* xvii. 25.

CHAP. VIII.

Of the Motion of Animals.

NEXT to the two Grand Acts of Animal Life, their Senſe or Reſpiration, I ſhall conſider their *Motion*, or *Locomotive Faculty*, whereby they convey themſelves from Place to Place, according to their Occaſions, and Way of Life: And the admirable Apparatus to this Purpoſe, is a plain Demonſtration of God's particular Foreſight, Care, and eſpecial Providence towards all the Animal World.

And here I might view, in the firſt Place, the Muſcles, their curious Structure (a), the nice tacking them to every Joint, to pull it this Way, and that Way, and the other Way, according to the ſpecial Purpoſe, Deſign, and Office of every ſuch Joint: Alſo their various Size and

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(a) That the Muſcles are compounded of Fibres, is viſible enough. Which Fibres, the curious and ingenious *Borelli* ſaith, are cylindraceous; not hollow, but filled with a ſpongy, pithy Subſtance, after the Manner of Elder, as he diſcovered by his Microſcopes. *Borel. de Mot. Animal. Part* 1.

Strength; ſome large and corpulent, others leſs, and ſome ſcarce viſible to the naked Eye; all exactly fitted to every Place, and every Uſe of the Body. And laſtly, I might take notice of the muſcular Motions, both involuntary and ſpontaneous *(b)*.

Next, I might ſurvey the ſpecial Fabrick of the Bones *(c)*, miniſtring to Animal Motion. Next, I might

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Theſe Fibres, he ſaith, are naturally white; but derive their Redneſs only from the Blood in them.

Theſe Fibres do in every Muſcle (in the Belly at leaſt of the Muſcle) run parallel to one another, in a neat, orderly Form. But they do not at all tend the ſame Way, but ſome run aſlant, ſome long-ways, *&c.* according to the Action or Poſition of each reſpective Muſcle. The Particulars of which, and of divers other Obſervables in the Muſcles, would, beſides Figures, take up too much Room in theſe Notes; and therefore I muſt refer to the Anatomiſts, particularly *Steno*, *Borelli*, *Cowper*, &c.

(b) The infinite Creator hath generally exerted his Art and Care, in the Proviſion made by proper Muſcles and Nerves, for all the different Motions in Animal Bodies, both involuntary and voluntary. It is a noble Providence, that moſt of the vital Motions, ſuch as of the Heart, Stomach, Guts, *&c.* are involuntary, the Muſcles acting whether we ſleep or wake, whether we will or no. And it is no leſs providential that ſome, even of the vital Motions, are partly voluntary, partly involuntary, as that, for Inſtance, of Breathing, which is performed both ſleeping and waking; but can be intermitted for a ſhort Time on Occaſion, as for accurate Hearing any Thing, *&c.* or can be increaſed by a ſtronger Blaſt, to make the greater Diſcharges of the Blood from the Lungs, when that any Thing overcharges them. And as for the other Motions of the Body, as of the Limbs, and ſuch as are voluntary, it is no leſs Providence, that they are abſolutely under the Power of the Will; ſo as that the Animal hath it in his Power to command the Muſcles and Spirits, or any Part of its Body, to perform ſuch Motions and Actions as it hath Occaſion for.

(c) Quid dicam de Oſſibus? quæ ſubjecta corpori mirabiles commiſſuras habent, & ad ſtabilitatem aptas, & ad artus finiendos accommodatas, & ad motum, & ad omnem corporis actionem. Cicer. de Nat. Deor. lib. ii. cap. 55.

By Reaſon it would be endleſs to mention all the Curioſities obſervable in the Bones, I ſhall for a Sample, ſingle out only an Inſtance or two, to manifeſt that Deſign was uſed in the Structure of theſe Parts in Man.

The firſt ſhall be in the *Back-Bone*, which (among many others) hath theſe two Things remarkable. 1. Its different Articulations from the other Joints of the Body. For here moſt of the Joints are flat, and withal guarded with Aſperities and Hollows, made for catching and holding; ſo as firmly to lock and keep the Joints from Luxations, but withal to afford them ſuch a Motion, as is neceſſary for the Incurvations of the Body. 2. The Difference of its own Joints in the Neck, Back, and Loins. In the Neck, the *Atlas*, or upper *Vertebra*, as alſo the *Dentata*, are curiouſly made, and jointed (differently from the reſt) for the commodious and eaſy bending and turning the Head every Way. In the *Thorax*, or Back, the Joints are made cloſe and firm; and in the Loins, more lax and pliant; as alſo the Spines are different, and the Knobs and Sockets turned the quite contrary Way, to anſwer the Occaſions the Body hath to bend more there, than higher in the Back. I ſhall cloſe this Remark with the ingenious Dr. *Keil*'s Obſervation.

The Structure of the Spine *is the very beſt that can be contrived; for had it been all Bone, we could have had no Motion in our Backs; had it been of two or three Bones articulated for Motion, the* Medulla Spinalis *muſt have been neceſſarily bruiſed at every Angle or Joint; beſides, the whole would not have been ſo pliable for the ſeveral Poſtures we have Occaſion to put ourſelves in. If it had been made of ſeveral Bones, without intervening Cartilages, we ſhould have had no more Uſe for it, than if it had been but one Bone. If each* Vertebra *had had its own Diſtinct Cartilages, it might have been eaſily* diſlocated. *And laſtly, The oblique Proceſſes of each ſuperior and inferior* Vertebra, *keep the Middle one that it can neither be thruſt backwards nor forwards to compreſs the* Medulla Spinalis. Keil's Anat. cap. 5. ſect. 8.

Compare here what *Galen* ſaith of the Articulations, Ligaments, Perforation, *&c.* of the *Spine*, to prove the Wiſdom and Providence of the Maker of Animal Bodies, againſt ſuch as found Fault with Nature's Works; among which he names *Diagoras*, *Anaxagoras*, *Aſclepiades* and *Epicurus*. *Vid. Galen de Uſ. Part. l.* 12. *init.* and *Chap.* 11, *&c.* alſo *l.* 13. *init.*

2. The next Inſtance ſhall be in one or two Things, wherein the Skeletons of Sexes differ. Thus the *Pelvis* made in the Belly by the *Ilium*, *Oſſa Coxendicis* and *Pubis*, is larger in a Female than Male Skeleton, that there may be more Room for the lying of the *Viſcera* and *Fœtus*. So the Cartilage bracing together the two *Oſſa Pubis*, or *Sharebones*, *Bartholine* ſaith, is twice thicker and laxer in Women than

might take Notice of the Joints *(d)*, their compleat Form adjuſted to the Place, and Office they are employed in; their Bandage, keeping them from Luxations; the oily Matter *(e)* to lubricate them,

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Men: as alſo is the Cartilage that tieth the *Os Sacrum* to its *Vertebra*; and all to give Way to the Paſſage of the *Fœtus*.

Another conſiderable Difference is in the cartilaginous Production of the ſeven long Ribs, whereby they are braced to the Breaſt-Bone. Theſe are harder and firmer in Women than in Men; the better to ſupport the Weight of the Breaſts, the ſucking Infant, &c.

(d) It is remarkable in the Joints, and a manifeſt Act of Caution and Deſign: 1. That although the Motion of the Limbs be circular, yet the Center of that Motion is not in a Point, but an ample Superficies. In a Point, the Bones would wear and penetrate one another; the Joints would be exceedingly weak, &c. but the Joints conſiſting of two large Superficies, Concave and Convex, ſome furrowed and ridged, ſome like a Ball and Socket, and all lubricated with an oily Subſtance, they are incomparably prepared both for Motion and Strength. 2. That the Bones next the Joint are not ſpungy, as their Extremities commonly are, nor hard and brittle, but capped with a ſtrong, tough, ſmooth, cartilaginous Subſtance, ſerving both to Strength and Motion.

But let us here take Notice of what *Galen* mentions on this Subject. *Articulorum unuſquiſque Eminentiam Cavitati immiſſam habet: Veruntamen hoc fortaſſe non adeò mirabile eſt: Sed ſi, conſideratâ omnium totius corporis oſſium mutuâ connexione, Eminentias cavitatibus ſuſcipientibus æquales ſemper inveneris: Hoc mirabile. Si enim juſto amplior eſſet Cavitas, laxus ſanè & infirmus fieret articulus; ſi ſtrictior, motus difficulter fieret, ut qui nullam verſionem haberet; ac periculum eſſet non parvum, eminentias oſſium arctatas frangi: ſed horum neutrum factum eſt. — Sed quoniam ex tam ſecurâ conſtructione periculum erat, nè motiones difficiliùs fierent, & eminentiæ oſſium extererentur, duplex rurſus auxilium in id Natura molita eſt. 1. Cartilagine os utrumque ſubungens, atque oblinens: alterum, ipſis Cartilaginibus humorem unctuoſum, velut oleum, ſuperfundens; per quem facilè mobilis, & attritu contumax omnis articulatio Oſſium facta eſt. —— Ut undique diligenter Articulus omnis cuſtodiretur, Ligamenta quædam ex utroque oſſe produxit Natura.* Galen de Uſ. Part. lib. i. cap. 15.

(e) For the affording this oily or mucilaginous Matter, there are *Glandules* very commodiouſly placed near the Joints,

them, and their own Smoothneſs to facilitate their Motion.

And laſtly, I might trace the various Nerves throughout the Body, ſent about to miniſter to its various Motions (*f*). I might conſider their Origin (*g*), their Ramifications to the ſeveral Parts, and their Inoſculations with one another, according to the Harmony and Accord of one Part with another, neceſſary for the Benefit of the Animal. But ſome of thoſe Things I have given ſome Touches upon already, and more I ſhall mention

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ſo as not to ſuffer too great Compreſſion by the Motion of the neighbouring Bones, and yet to receive a due Preſſure, ſo as to cauſe a ſufficient Emiſſion of the Mucilage into the Joints. Alſo, another Thing conſiderable is, that the excretory Ducts of the *Mucilaginous Glands* have ſome Length in their Paſſage from the Glands to their Mouths; which is a good Contrivance, to prevent their Mouths being oppreſſed by the Mucilage, as alſo to hinder the too plentiful Effuſion thereof, but yet to afford a due Expreſſure of it at all Times, and on all Occaſions, as particularly in violent and long-continued Motions of the Joints, when there is a greater than ordinary Expence of it. See *Cowper's Anat. Tab.* 79.

(*f*) There is no Doubt to be made, but that the Muſcles receive their Motion from the Nerves. For if a Nerve be cut, or ſtreightly bound, that goes to any Muſcle, that Muſcle ſhall immediately loſe its Motion. Which is doubtleſs the Caſe of Paralyticks; whoſe Nerves are ſome of them by Obſtructions, or ſuch like Means, reduced to the ſame State as if cut or bound.

And this alſo is the Cauſe of that *Numbneſs* or *Sleepineſs* we find oftentimes, by long ſitting or lying on any Part.

Neither is this a modern Notion only; for *Galen* ſaith, *Principium Nervorum omnium Cerebrum eſt, & ſpinalis Medulla. — Et Nervi à Cerebro animalem virtutem accipiunt — Nervorum utilitas eſt facultatem Senſûs & Motûs à principio in partes diducere.* And this he intimates to have been the Opinion of *Hippocrates* and *Plato*, de Uſ. Part. lib. i. cap. 16. & paſſim.

(*g*) Dr. *Willis* thinks, that in the *Brain* the Spirits are elaborated that miniſter to voluntary Motion; but in the *Cerebellum*, ſuch as affect involuntary, or natural Motions; ſuch as that of the Heart, the Lungs, &c. *Cerebri Anat.* cap. 15.

hereafter (*b*), and it would be tedious here to inſiſt upon them all.

I ſhall therefore only ſpeak diſtinctly to the Locomotive Act itſelf, or what directly relates to it.

And here it is admirable to conſider the various Methods of Nature (*i*), ſuited to the Occaſions of various Animals. In ſome their Motion is ſwift, in others ſlow; in ſome performed with two, four, or more Legs; in ſome with two, or four Wings; in ſome with neither (*k*).

And firſt for ſwift or ſlow Motions. This we find is proportional to the Occaſions of each reſpective Animal. *Reptiles*, whoſe Food, Habitation, and Neſts, lie in the next Clod, Plant, Tree, or Hole, or can bear long Hunger and Hardſhip, they need neither Legs nor Wings for their Tranſportation;

(*b*) See *Book* V. *Chap.* viii.

(*i*) To the foregoing I ſhall briefly add ſome Examples of the ſpecial Proviſion made for the Motion of ſome Animals by *Temporary Parts*. *Frogs* and *Toads*, in their *Tadpole-ſtate*, have Tails, which fall off when their Legs are grown out. The *Lacerta Aquatica*, or *Water-Newt*, when young, hath four neat ramified Fins, two on a Side, growing out a little above its Fore-Legs, to poiſe and keep its Body upright, (which gives it the Reſemblance of a young Fiſh,) which fall off when the Legs are grown. And the *Nymphæ* and *Aureliæ*, of all or moſt of the Inſects bred in the Waters, as they have particular Forms, different from the Inſects they produce; ſo have alſo peculiar Parts afforded them for their Motion in the Waters: Oars, Tails, and every Part adapted to the Waters, which are utterly varied in the Inſects themſelves, in their *mature State* in the Air.

(*k*) *Jam verò alia animalia gradiendo, alia ſerpendo, ad paſtum accedunt, alia volando, alia nando.* Cic. de Nat. Deor. lib. ii. cap. 47.

Compare alſo what *Galen* excellently obſerves concerning the Number of Feet in Man, and in other Animals; and the wiſe Proviſion thereby made for the Uſe and Benefit of the reſpective Animals. *De Uſ. Part.* in the Beginning of the third Book.

but their vermicular or ſinuous Motion (performed with no leſs Art, and as curiouſly provided for as the Legs or Wings of other Creatures: This, I ſay,) is ſufficient for their Conveyance.

Man and *Beaſts*, whoſe Occaſions require a large Room, have accordingly a ſwifter Motion, with proper Engines for that Service; anſwerable to their Range for Food, their Occupation of Buſineſs, or their Want of Armature, and to ſecure them againſt Harms *(l)*.

But for the winged Creatures (Birds and Inſects,) as they are to traverſe large Tracts of Land and Water for their Food, for their commodious Habitation, or Breeding their Young, to find Places of Retreat and Security from Miſchiefs; ſo they have accordingly the Faculty of flying in the Air; and that ſwiftly or ſlowly, a long or a ſhort Time, according to their Occaſions and Way of Life. And accordingly their Wings, and whole Body, are curiouſly prepared for ſuch a Motion; as I intend to ſhew in a proper Place *(m)*.

Another remarkable Thing in the motive Faculty of all Creatures, is the neat, geometrical Performance of it. The moſt accurate Mathematician, the moſt ſkilful in mechanic Motions, cannot preſcribe a nicer Motion (than what they perform) to

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(l) As I ſhall hereafter ſhew, That the indulgent Creator hath abundantly provided for the Safety of Animals by their Cloathing, Habitations, Sagacity, and Inſtruments of Defence; ſo there appears to be a Contemperament of their *Motion* with theſe Proviſions, They that are well armed and guarded, have commonly a ſlow Motion; whereas they that are deſtitute thereof, are ſwifter. So alſo timid helpleſs Animals are commonly ſwift; thus Deer and Hares: But Animals endowed with Courage, Craft, Arms, &c. commonly have a ſlower Motion.

(m) See *Book* VII. *Chap*. i.

the Legs and Wings of thoſe that walk or fly (*n*), or to the Bodies of thoſe that creep (*o*). Neither can the Body be more compleatly poiſed for the Motion it is to have in every Creature, than it already actually is. From the largeſt Elephant to the ſmalleſt Mite, we find the Body artfully balanced (*p*). The Head not too heavy, nor too light for the reſt of the Body, nor the reſt of the Body for it (*q*). The *Viſcera* are not let looſe, or ſo placed as to ſwag, over-balance, or over-ſet the Body; but well-braced, and diſtributed to maintain the Æquipoiſe of the Body. The motive Parts alſo are admirably well fixed in reſpect to the Center of Gravity; placed in the very Point, fitteſt to ſupport and convey the Body. Every Leg beareth his true Share of the Body's Weight. And the Wings ſo nicely are ſet to the Center of Gravity, as even in that fluid *Medium*, the Air, the Body is as truly balanced, as we could have balanced it with the niceſt Scales.

(*n*) See *Book* VII. *Chap*. i. the End.

(*o*) See *Book* IX. *Chap*. i. *Note* (*c*).

(*p*) *Siquis unquam alius Opifex, æqualitatis & proportionis magnam habuit providentiam, certè Natura habuit in animalium corporibus conformandis; unde Hippocrates eam rectiſſimè juſtam nominat.* Galen de Uſ. Part. lib. ii. cap. 16.

(*q*) The Make of the Bodies of ſome Water-Fowl, ſeems to contradict what I here ſay; the Heads and long Necks of ſome, as of Swans, Ducks, and Geeſe; and the hinder Parts of others, as of the Doucker and Moor hen, and ſome other Kinds, ſeeming to be too heavy for the reſt of their Body. But inſtead of being an Argument againſt, it is a notable Inſtance of, the divine Art and Providence, theſe Things being nice Accommodations to their Way of Life. Of ſuch as have long Necks, ſee *Book* VII. *Chap*. ii. *Note* (*i*).

And as for ſuch whoſe hinder Parts ſeem to over-balance their foremoſt Parts, whereby they fly with their Bodies in a manner erect, this alſo is an excellent Accommodation to their Way of Life, which is Diving rather than Flying. See *Book* VII. *Chap*. iv. *Note* (*k*).

But among all Creatures, none more elegant than the ſizing the Body of *Man*, the gauging his Body ſo nicely, as to be able to ſtand erect, to ſtoop, to ſit, and indeed to move any Way, only with the Help of ſo ſmall a Stay as the Feet *(r)*: whoſe Mechaniſm of Bones, Tendons, and Muſcles to this Purpoſe, is very curious and admirable.

(r) See *Book* V. *Chap.* ii. *Note (h).*

CHAP. IX.

Of the Place allotted to the ſeveral Tribes of Animals.

HAving diſpatched the Motion of Animals, let us in the next Place conſider the *Place* which the infinitely wiſe Creator hath appointed them to move and act, and perform the Offices of the Creation in. And here we find every Particular well ordered. All Parts of our Terraqueous Globe fit for an Animal to live and act in, are ſufficiently ſtocked with proper Inhabitants: The watery Element (unfit, one would think, for Reſpiration and Life) abounding with Creatures fitted for it; its Bowels abundantly ſtored, and its Surface well beſpread. The Earth alſo is plentifully ſtocked in all its Parts, where Animals can be of any Uſe; not probably the deepeſt Bowels thereof indeed, being Parts in all likelihood unfit for Habitation and Action, and where a living Creature would be uſeleſs in the World; but the Surface every where abundantly ſtored.

But that which is moſt conſiderable in this Matter, and plainly ſheweth the Divine Management in the Caſe, is, that thoſe Creatures are manifeſtly deſigned for the Place in which they are, and the Uſe and Services they perform therein. If all the Animals of our Globe had been made by Chance, or placed by Chance, or without the divine Providence, their Organs would have been otherwiſe than they are, and their Place and Reſidence confuſed and jumbled. Their Organs (for Inſtance) of Reſpiration, of Viſion, and of Motion, would have fitted any *Medium*, or have needed none; their Stomachs would have ſerved any Food, and their Blood, and Covering of their Bodies been made for any Clime, or only one Clime. Conſequently all the Animal World would have been in a confuſed, inconvenient, and diſorderly Commixture. One Animal would have wanted Food, another Habitation, and moſt of them Safety. They would have all flocked to one, or a few Places, taken up their Reſt in the Temperate Zones only, and coveted one Food, the eaſieſt to be come at, and moſt ſpecious in ſhew; and ſo would have poiſoned, ſtarved, or greatly incommoded one another. But as the Matter is now ordered, the Globe is equally beſpread, ſo that no Place wanteth proper Inhabitants, nor any Creature is deſtitute of a proper Place, and all Things neceſſary to its Life, Health, and Pleaſure. As the Surface of the Terraqueous Globe is covered with different Soils, with Hills and Vales, with Seas, Rivers, Lakes, and Ponds, with divers Trees and Plants, in the ſeveral Places; ſo all theſe have their Animal Inhabitants, whoſe Organs of Life and Action are manifeſtly adapted to ſuch and ſuch Places and Things; whoſe Food and Phyſick, and every other Convenience of Life, is to be met with in that very Place appointed it. The watery, the amphibious (*a*), the airy Inhabitants, and thoſe on the dry Land Surface, and the Subterraneous under it, they all live, and act with Pleaſure, they are gay, and flouriſh in their proper Element and allotted Place, they want neither for Food, Cloathing, or Retreat; which would dwindle and die, deſtroy, or poiſon one another, if all coveted the ſame Element, Place, or Food.

Nay, and as the Matter is admirably well ordered, yet conſidering the World's Increaſe, there would not be ſufficient Room, Food, and other Neceſſaries for all the living Creatures, without another grand Act of the Divine Wiſdom and Providence, which is, the *Balancing the Number of Individuals* of each Species of Creatures, in that Place appointed thereto: Of which in the next Chapter.

(*a*) *Eſt etiam admiratio nonnulla in beſtiis aquatilibus iis, quæ gignuntur in terrâ: veluti Crocodili, fluviatileſque Teſtudines, quædamque Serpentes ortæ extra aquam, ſimul ac primùm niti poſſunt, aquam perſequuntur. Quin etiam Anatum ova Gallinis ſæpe ſupponimus* — [Pulli] *deinde eas* [matres] *relinquunt* — *& effugiunt, cùm primùm aquam, quaſi naturalem domum, videre potuerunt.* Cic. de Nat. Deor. lib. ii. cap. 48.

CHAP. X.

Of the Balance of Animals, or the due Proportion in which the World is ſtocked with them.

THE whole Surface of our Globe can afford Room and Support only to ſuch a Number of all Sorts of Creatures; and if by their doubling, trebling, or any other Multiplication of their

Kind, they ſhould increaſe to doubl
Number, they muſt ſtarve, or devo
The keeping therefore the Balance
feſtly a Work of the Divine Wiſdo
dence. To which End, the great
hath determined the Life of all Cre
Length, and their Increaſe to ſuch
portional to their Uſe in the World
ſome Creatures is long, and their Inc
and by that Means they do not over-
And the ſame Benefit is effected, wh
is great, by the Brevity of ſuch Crea
their great Uſe, and the frequent
are of them for Food to Man, or
It is a very remarkable Act of th
dence, that uſeful Creatures are pr
Plenty *(a)*, and others in leſs The
frequent Increaſe of Inſects, both
the Waters, may exemplify the or
ſervable in the other, that Creature
by their Voracity pernicious, have
Young, or do ſeldomer bring fo
many Inſtances may be given i
Beaſts and Birds. But there is or
Animal, as if made for a particula
preſent Caſe, and that is the *Cuntur*

(a) Benigna circa hoc Natura, innocua
fæcunda generavit. Plin. Nat. Hiſt. lib. v

(b) Captain J. Strong *gave me this Acc*
Quill Feather of the Cuntur [*or* Condo
Coaſt of Chili, *they met with this Bird in a*
far from Mocha, *an Iſland in the South Sea*
a Cliff, by the Sea Side; *that it was* 16 *Fe*
extended; *that the* Spaniſh *Inhabitants told*
of theſe Birds, leſt they ſhould prey upon thei
Feather he gave me (ſaith the Doctor) *is*
the Quill-Part 5 *Inches three Quarters long,*
about in the largeſt Part. It weighed 3 *dr.*

Fowl of that Magnitude, Strength and Appetite, as to ſeize not only on the Sheep, and leſſer Cattle, but even the larger Beaſts, yea, the very Children too. Now theſe, as they are the moſt pernicious of Birds, ſo are they the moſt rare, being ſeldom ſeen, or only one, or a few in large Countries; enough to keep up the Species, but not to over-charge the World.

Thus the Balance of the Animal World, is, throughout all Ages, kept even; and by a curious Harmony, and juſt Proportion between the Increaſe of all Animals, and the Length of their Lives, the World is through all Ages well, but not over-ſtored: *One Generation paſſeth away, and another Generation cometh* (c); ſo equally in its Room, to Balance the Stock of the Terraqueous Globe in all Ages, and Places, and among all Creatures; that it is

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is of a dark brown Colour. Dr. *Sloane* in Philoſoph. Tranſact. N° 208.

To this Account, the Doctor (in a Letter to Mr. *Ray*, *March* 31, 1694, with other Papers of Mr. *Ray*'s, in my Hands,) adds the Teſtimony of *Joſ. Acoſta*, lib. iv. cap. 7. and *Garcillaſſ. de la Vega*, who, lib. viii. cap. 19. ſaith, *There are other Fowls, called* Cuntur, *and by the* Spaniards *corruptly* Condor. *Many of theſe Fowls having been killed by the* Spaniards, *had their Proportion taken, and from End to End of their Wings meaſured* 15 *or* 16 *Feet.* — *Nature, to temper and allay their Fierceneſs, denied them the Talons which are given to the* Eagle; *their Feet being tipped with Claws like a Hen: However, their Beak is ſtrong enough to tear off the Hide, and rip up the Bowels of an* Ox. *Two of them will attempt a* Cow *or* Bull, *and devour him: And it hath often happened, that one of them alone hath aſſaulted Boys of ten or twelve Years of Age, and eaten them. Their Colour is black and white like a* Magpie. *It is well there are but few of them; for if there were many, they would very much deſtroy the Cattle. They have on the Fore-Part of their Heads a Comb, not pointed like that of a* Cock; *but rather even, in the Form of a Razor. When they come to alight from the Air, they make ſuch a humming Noiſe, with the fluttering of their Wings, as is enough to aſtoniſh, or make a Man deaf.*

(c) *Eccleſ.* i. 4.

is an actual Demonſtration of our Saviour's
on, *Mat.* x. 29. that the moſt inconſiderable
mon Creature, *Even a Sparrow (two of which
for a Farthing) doth not fall on the Ground wit
heavenly Father.*

This Providence of God is remarkable i
Species of living Creatures: But that eſpec
nagement of the Recruits and Decays of M
ſo equally all the World over, deſerves ou
cial Obſervation. In the Beginning of the
and ſo after *Noah*'s Flood, the Longævity o
as it was of abſolute Neceſſity to the more
Peopling of the new World; ſo is a ſpec
ſtance of the Divine Providence in this Matt

(d) The Divine Providence doth not only appea
Longævity of Man, immediately after the Creation an
but alſo in their different Longævity at thoſe two Tim
mediately after the Creation, when the World was to be
by one Man and one Woman, the Age of the greateſ
thoſe on Record was 900 Years, and upwards. But
Flood, when there were three Perſons by whom the W
to be peopled, none of thoſe Patriarchs except *Shem*, a
the Age of 500; and only the three firſt of *Shem*'s Li
Arphaxad, *Salah*, and *Eber*, came near that Age: w
in the firſt Century after the Flood. But in the ſeco
tury, we do not find any reached the Age of 240. A
third Century, (about the latter End of which *Abra*
born) none, except *Terah*, arrived to 200 Years: E
Time the World was ſo well peopled, (that Part of i
where *Abraham* dwelt,) that they had built Cities, a
to be cantoned into diſtinct Nations and Societies, un
reſpective Kings; ſo that they were able to wage W
Kings againſt five, *Gen.* xiv. Nay, if the Accounts
Beroſus, *Manetho*, and others, yea, *Africanus*, be to be
the World was ſo well peopled, even before the Times
of, as to afford ſufficient Numbers for the great Kin
Aſſyria, *Egypt*, *Perſia*, &c. But learned Men genera
great Reaſon, reject theſe as legendary Accounts.

If the Reader hath a mind to ſee a Computation o
creaſe of Mankind, in the three firſt Centuries after t
he may find two different Ones of the moſt learned A

And the ſame Providence appears in the following Ages, when the World was pretty well peopled, in reducing the common Age of Man then to 120 Years, (*Gen.* vi. 3.) in Proportion to the Occaſions of the World at that Time. And laſtly; when the World was fully peopled after the Flood, (as it was in the Age of *Moſes*, and ſo down to our preſent Time) the leſſening the common Age of Man to 70 or 80 Years (*e*), (the Age mention'd by *Moſes*,

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Uſher, and *Petavius*; together with a Refutation of the ſo early Beginning of the *Aſſyrian Monarchy*; as alſo Reaſons for placing *Abraham* near 1000 Years after the Flood, in our moſt learned Biſhop *Stillingfleet*'s *Orig. Sacr.* book III. chap. iv. ſect. 9.

(*e*) That the common Age of Man hath been the ſame in all Ages ſince the World was peopled, is manifeſt from prophane as well as ſacred Hiſtory. To paſs by others, *Plato* lived to the Age of 81, and was accounted an old Man. And thoſe which *Pliny* reckons up, lib. vii. cap. 48. as rare Examples of long Life, may for the moſt Part be matched by our modern Hiſtories; eſpecially ſuch as *Pliny* himſelf gave Credit unto. Dr. *Plot* has given us divers Inſtances in his Hiſtory of *Oxfordſhire*, chap. ii. ſect. 3. and chap. viii. ſect. 54. and Hiſtory of *Staffordſhire*, chap. viii. ſect. 91, &c. Among others, one is of twelve Tenants of Mr. *Biddulph*'s, that together made 1000 Years of Age. But the moſt conſiderable Examples of aged Perſons among us, is of old *Parre* of *Shropſhire*, who lived 152 Years 9 Months, according to the learned Dr. *Harvey*'s Account; and *Henry Jenkins* of *Yorkſhire*, who lived 169 Years, according to the Account of my learned and ingenious Friend Dr. *Tancred Robinſon*, of both which, with others, ſee *Lowth. Abridg. Philoſoph. Tranſact.* vol. iii. p. 306. The great Age of *Parre* of *Shropſhire*, minds me of an Obſervation of the Reverend Mr. *Plaxton*, that in his two Pariſhes of *Kinardſey* and *Donington* in *Shropſhire*, every ſixth Soul was ſixty Years of Age, or upwards. *Phil. Tranſ.* N° 310.

And if we ſtep farther North, into *Scotland*, we ſhall find divers recorded for their great Age: Of which I ſhall preſent the Reader with only one modern Example of one *Laurence*, who married a Wife after he was 100 Years of Age, and would go out to Sea a-fiſhing in his little Boat, when he was 140 Years old; and is lately dead of no other Diſtemper but mere old Age, *ſes*, *Pſal.* xc. 10. this, I ſay,) is manifeſtly an Appointment of the ſame infinite Lord that ruleth the World: For, by this Means, the peopled World is kept at a convenient Stay; neither too full, nor too empty. For if Men (the Generality of them, I mean) were to live now to *Methuſelah*'s Age of 969 Years, or only to *Abraham*'s, long after the Flood, of 175 Years, the World would be too much over-run; or if the Age of Man was limited to that of divers other Animals, to ten, twenty, or thirty Years only; the Decays then of Mankind would be too faſt: But at the middle Rate mentioned, the Balance is nearly even, and Life and Death keep an

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Age, ſaith Sir *Robert Sibbald*, *Prodr. Hiſt. Nat. Scot.* p. 44. and lib. iii. p. 4.

As for Foreigners, the Examples would be endleſs; and therefore that of *Joh. Ottele* ſhall ſuffice, who was as famous for his Beard, as for being 115 Years of Age. He was but two *Brabant* Ells $\frac{3}{9}$ high; and his long grey Beard was one Ell $\frac{3}{4}$ long. His Picture and Account may be ſeen in *Ephem. Germ.* tom. iii. *Obſ.* 163.

As for the Story *Roger Bacon* tells, of one that lived 900 Years by the Help of a certain Medicine, and many other ſuch Stories, I look them upon as fabulous. And no better is that of the *Wandering Jew*, named *Joh. Buttadeus*, ſaid to have been preſent at our Saviour's Crucifixion; although very ſerious Stories are told of his being ſeen at *Antwerp*, and in *France*, about the Middle of the laſt Century but one; and before, in *Ann.* 1542, converſed with by *Paul* of *Etſen*, Biſhop of *Sleſwick*; and before that, *viz.* in 1228, ſeen and converſed with by an *Armenian Archbiſhop's Gentleman*; and by others at other Times.

If the Reader hath a Mind to ſee more Examples, he may meet with ſome of all Ages, in the learned *Hakewill's Apol.* p. 181. where he will alſo find that learned Author's Opinion of the Cauſes of the Brevity and Length of human Life. The Brevity thereof he attributeth to a too tender Education, ſucking ſtrange Nurſes, too haſty Marriages; but above all to Luxury, high Sauces, ſtrong Liquors, &c. The Longævity of the Ancients he aſcribes to Temperance in Meat and Drink, anointing the Body, the Uſe of Saffron and Honey, warm Cloaths, leſſer Doors and Windows, leſs Phyſick, and more Exerciſe.

equal Pace. Which Equality is ſo great and harmonious, and ſo manifeſt an Inſtance of the divine Management, that I ſhall ſpend ſome Remarks upon it.

It appears from our beſt Accounts of theſe Matters, that in our *European* Parts (*f*) and I believe the ſame is throughout the World; that, I ſay, there is a certain Rate and Proportion in the Propagation

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(*f*) The Proportions which *Marriages* bear to *Births*, and *Births* to *Burials*, in divers Parts of *Europe*, may be ſeen at an eaſy View in this

TABLE.

Names of the Places.	Marriages to Births: As	Births to Burials: As
England in general	1 to 4‘63	1‘12 to 1
London	1 to 4‘	1 to 1‘1
Hantſhire, from 1569, to 1658,	1 to 4‘	1‘2 to 1
Tiverton in *Devon*, 1560 to 1649,	1 to 3‘7	1‘26 to 1
Cranbrook in *Kent*, 1560 to 1649,	1 to 3‘9	1‘6 to 1
Aynho in *Northamptonſh.* for 118 Years,	1 to 6‘	1‘6 to 1
Leeds in *Yorkſhire*, 122 Years,	1 to 3‘7	1‘07 to 1
Harwood in *Yorkſhire*, 57 Years,	1 to 3‘4	1‘23 to 1
Upminſter in *Eſſex*, 100 Years,	1 to 4‘6	1‘08 to 1
Francfort on the *Main*, in 1695,	1 to 3‘7	1‘2 to 1
Old, *Middle*, & *Lower Marck*, in 1698,	1 to 3‘7	1‘9 to 1
Domin. of the K. of *Pruſſia*, in 1698,	1 to 3‘7	1‘5 to 1
Breſlaw in *Sileſia*, from 1687 to 1691,		1‘6 to 1
Paris in 1670, 1671, 1672,	1 to 4‘7	1 to 1‘6

Which Table I made from Major *Graunt*'s Obſervations on the Bills of Mortality; Mr. *King*'s Obſervations in the firſt of Dr. *Davenant*'s Eſſays; and what I find put together by my ingenious Friend Mr. *Lowthorp*, in his *Abridgment*, vol. iii. p. 668. and my own Regiſter of *Upminſter*. That from *Aynho*'s Regiſter in *Northamptonſhire*, I had from the preſent Rector, the learned and ingenious Mr. *Waſſe*: And I was promiſed ſome Accounts from the North, and divers other Parts of this Kingdom; but have not yet received them: Only thoſe of *Leeds* and *Harwood* in *Yorkſhire*, from my curious and ingenious Friend Mr. *Thoreſby*.

pagation of Mankind: Such a Number marry (*g*), ſo many are born, ſuch a Number die; in Proportion to the Number of Perſons in every Nation, County, or Pariſh. And as to Births, two Things are very conſiderable: One is the Proportion of Males and Females (*h*), not in a wide Proportion, not

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(*g*) The preceding Table ſhews, that Marriages, one with another, do each of them produce about four Births; not only in *England*, but in other Parts of *Europe* alſo.

And by Mr. *King*'s Eſtimate, (the beſt Computations I imagine of any, being derived from the beſt Accounts; ſuch as the Marriage, Birth, Burial-Act, the Poll-Books, *&c.* by his Eſtimate, I ſay), about 1 in 104 marry. For he judgeth the Number of the People in *England* to be about five Millions and a half; of which about 41000 annually marry. As to what might be farther remarked concerning Marriages, in regard of the Rites and Cuſtoms of ſeveral Nations, the Age to which divers Nations limited Marriages, *&c.* it would be endleſs, and too much out of the Way to mention them: I ſhall only therefore, for the Reader's Diverſion, take Notice of the Jeer of *Lactantius*, *Quare apud Poetas ſalaciſſimus* Jupiter *deſiit liberos tollere? Utrum ſexagenarius factus, & ei Lex Papia fibulam impoſuit?* Lactan. Inſtit. lib. i. cap. 16. By which *Lex Papia*, Men were prohibited to marry after 60, and Women after 50 Years of Age.

(*h*) Major *Graunt*, (whoſe Concluſions ſeem to be well-grounded,) and Mr. *King*, diſagree in the Proportions they aſſign to Males and Females: This latter makes in *London* 10 Males to be to 13 Females; in other Cities and Market-Towns, 8 to 9; and in the Villages and Hamlets, 100 Males to 99 Females. But Major *Graunt*, both from the *London* and *Country* Bills, ſaith, there are 14 Males to 13 Females; from whence he juſtly infers, *That the Chriſtian Religion, prohibiting Polygamy, is more agreeable to the Law of Nature than* Mahometiſm, *and others that allow it.* Chap. 8.

This Proportion of 14 to 13, I imagine is nearly juſt, it being agreeable to the Bills I have met with, as well as thoſe in Mr. *Graunt*. In the 100 Years, for Example, of my own Pariſh-Regiſter, although the Burials of Males and Females were nearly equal, being 636 Males and 623 Females, in all that Time; yet there were baptized 709 Males, and but 675 Females, which is 13 Females to 13'7 Males. Which Inequality ſhews, not only, that one Man ought to have but one Wife; but alſo that every Woman may, without Polygamy, have an Huſband, if ſhe doth not bar herſelf by the Want of Virtue, by Denial, *&c.* Alſo this Surpluſage of Males is very uſeful for the Supplies not an uncertain, accidental Number at all Adventures; but nearly equal. Another Thing is, that a few more are born than appear to die, in any certain Place *(i)*. Which is an admirable Proviſion for the extraordinary Emergencies and Occaſions of the World; to ſupply unhealthful Places, where Death out-runs Life; to make up the Ravages of great Plagues, and Diſeaſes, and the Depredations of War, and the Seas; and to afford a ſufficient Number for Colonies in the unpeopled Parts of the Earth. Or on the other Hand, we may ſay, that ſometimes thoſe extraordinary Expences of Mankind, may be not only a juſt Puniſhment of the Sins of Men; but alſo a wiſe Means to keep the Balance of Mankind even; as one would be ready to conclude, by conſidering the *Aſiatick*, and other the more fertile Countries, where prodigious Multitudes are yearly ſwept away with great Plagues, and ſometimes War; and yet thoſe Countries are ſo far from being waſted, that they remain full of People. And

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plies of War, the Seas, and other ſuch Expences of the Men above the Women.

That this is a Work of the Divine Providence, and not a Matter of Chance, is well made out by the very Laws of Chance, by a Perſon able to do it, the ingenious and learned Dr. *Arbuthnot*. He ſuppoſeth *Thomas* to lay againſt *John*, that for eighty-two Years running, more Males ſhall be born than Females; and giving all Allowances in the Computation to *Thomas's* Side, he makes the Odds againſt *Thomas*, that it doth not happen ſo, to be near five Millions of Millions, of Millions, of Millions to one; but for Ages of Ages (according to the World's Age) to be near an infinite Number to one againſt *Thomas*. *Vide Phil. Tranſ.* N° 338.

(i) The foregoing Table ſhews, that in *England* in general, fewer die than are born, there being but 1 Death to $1\frac{12}{100}$ Births. But in *London* more die than are born. So by Dr. *Davenant's* Table, the Cities likewiſe and Market-Towns bury $1\frac{7}{100}$ to one Birth. But in *Paris* they out-do *London*, their Deaths being $1\frac{1}{2}$ to one Birth: The Reaſon of which I conceive is, becauſe their Houſes are more crowded than in *London*. But in the Villages of *England*, there are fewer die than are born, there being but 1 Death to $1\frac{17}{100}$ Births. And yet Major *Graunt*, and Dr. *Davenant*, both obſerve, that

there

And now, upon the whole Matter, what is all this but admirable and plain Management? What can the maintaining, throughout all Ages and Places, theſe Proportions of Mankind, and all other Creatures; this Harmony in the Generations of Men be, but the Work of one that ruleth the World? Is it poſſible that every Species of Animals ſhould ſo evenly be preſerved, proportionate to the Occaſions of the World? that they ſhould be ſo well balanced in all Ages and Places, without the Help of Almighty Wiſdom and Power? How is it poſſible, by the bare Rules, and blind Acts of Nature, that there ſhould be any tolerable Proportion; for Inſtance, between Males and Females, either of Mankind, or of any other Creature (k); eſpecially ſuch as are of a ferine, not of a domeſtick Nature, and conſequently out of the Command and Management of Man? How could Life and Death keep ſuch an even Pace through all the Animal World? If we ſhould take it for granted, that, according to the Scripture Hiſtory, the World had a Beginning, (as who can deny it (l)?

or

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there are more Breeders in *London*, and the Cities and Market Towns, than are in the Country, notwithſtanding the *London* Births are fewer than the Country; the Reaſon of which ſee in *Graunt*, chap. 7. and *Davenant*, *ubi ſupra*, p. 21.

The laſt Remark I ſhall make from the foregoing Table, ſhall be, that we may from thence judge of the Healthfulneſs of the Places there mentioned. If the Year 1698 was the mean Account of the three *Marcks*, thoſe Places bid the faireſt for being moſt healthful; and next to them *Aynho* and *Cranbrook* for *Engliſh* Towns.

(k) *Quid loquar, quanta ratio in beſtiis ad perpetuam conſervationem earum generis appareat? Nam primùm aliæ Mares, aliæ Fœminæ ſunt, quod perpetuitatis cauſâ machinata natura eſt.* Cic. de Nat. Deor. lib. ii. cap. 51.

(l) Although *Ariſtotle* held the Eternity of the World, yet he ſeems to have retracted that Opinion, or to have had a different Opinion when he wrote his *Metaphyſicks*; for in his firſt or if we ſhould ſuppoſe the Deſtruction thereof by *Noah*'s Flood: How is it poſſible, after the World was repleniſhed,) that in a certain Number of Years, by the greater Increaſes and Doublings of each Species of Animals, that, I ſay, this Rate of *Doubling (m)* ſhould ceaſe; or, that it ſhould be com-

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Book he affirms, that *God is the Cauſe and Beginning of all Things*: and in his Book *de Mundo*, he ſaith, *There is no Doubt but God is the Maker and Conſervator of all Things in the World.* And the *Stoick*'s Opinion is well known, who ſtrenuouſly contended, That the Contrivance and Beauty of the Heavens and Earth, and all Creatures, was owing to a wiſe, intelligent Agent. Of which *Tully* gives a large Account in his ſecond Book *de Nat. Deor.* in the Perſon of *Balbus*.

(m) I have before, in *Note (g)*, obſerved, That the ordinary Rate of the Doubling or Increaſe of Mankind is, that every Marriage, one with another, produces about four Births; but ſome have much exceeded that. *Babo*, Earl of *Abenſperg*, had thirty-two Sons and eight Daughters; and being invited to hunt with the Emperor *Henry* II. and bring but few Servants, brought only one Servant, and his thirty-two Sons. To theſe many others might be added; but one of the moſt remarkable Inſtances I have any where met with, is that of Mrs. *Honywood*, mentioned by *Hakewill*, *Camden*, and other Authors; but having now before me the Names, with ſome Remarks, (which I received from a pious neighbouring Deſcendant of the ſame Mrs. *Honywood*) I ſhall give a more particular Account than they. Mrs. *Mary Honywood* was Daughter, and one of the Coheireſſes, of *Robert Atwaters*, Eſq. of *Lenham*, in *Kent*. She was born in 1527. Married in *February* 1543. at ſixteen Years of Age, to her only Huſband, *Robert Honywood*, of *Charing* in *Kent*, Eſq. She died in the ninety-third Year of her Age, in *May* 1620. She had ſixteen Children of her own Body, ſeven Sons and nine Daughters; of which one had no Iſſue, three died young, and the youngeſt was ſlain at *Newport* Battle, *June* 20, 1600. Her Grand-children in the ſecond Generation were one hundred and fourteen; in the third, two hundred and twenty-eight; and nine in the fourth Generation. So that ſhe could ſay the ſame that the Diſtich doth, made of one of the *Dalburg*'s Family of *Baſil*:

1 2 3 4
Mater ait Natæ, dic Natæ, filia Natam
5 6
Ut moneat, Natæ, plangere Filiolam.

Riſe

compenſated by ſome other Means? That the World ſhould be as well, or better ſtocked than now it is, in 1656 Years, (the Time between the Creation and the Flood; this) we will ſuppoſe may be done by the natural Method of each Species Doubling or Increaſe: But in double that Number of Years, or at this Diſtance from the Flood, of 4000 Years, that the World ſhould not be overſtocked, can never be made out, without allowing an infinite Providence.

I conclude then this Obſervation with the Pſalmiſt's Words, *Pſal.* civ. 29, 30. *Thou hideſt thy Face, all Creatures are troubled; thou takeſt away their Breath, they die, and return to their Duſt. Thou ſendeſt forth thy Spirit, they are created; and thou reneweſt the Face of the Earth.*

Riſe up[1] *Daughter, and go*[2] *to thy Daughter*[3]*, for her Daughter's*[4] *Daughter hath a Daughter.* Mrs. *Honywood* was a very pious Woman, afflicted, in her declining Age, with Deſpair, in ſome meaſure; concerning which, ſome Divines once diſcourſing with her, ſhe in a Paſſion ſaid, *She was as certainly damned as this Glaſs is broken,* (throwing a *Venice* Glaſs againſt the Ground, which ſhe had then in her Hand.) But the Glaſs eſcaped breaking, as credible Witneſſes atteſted.

CHAP. XI.

Of the Food of Animals.

THE preceding Reflection of the *Pſalmiſt*, mindeth me of another Thing in common to Animals, that pertinently falleth next under Conſideration, which is, the *Appointment of Food*, mentioned in *Verſe* 27, 28, of the laſt cited *Pſal.* civ. *Theſe* [Creatures] *wait all upon thee, that thou mayeſt give them their Meat in due Seaſon. That thou giveſt them, they gather; thou openeſt thy Hand, they are filled with Good.* The ſame is again aſſerted in *Pſal.* cxlv. 15, 16. *The Eyes of all wait upon thee, and thou giveſt them their Meat in due Seaſon. Thou openeſt thy Hand, and ſatisfieſt the Deſire of every living Thing.*

What the *Pſalmiſt* here aſſerts, affords us a glorious Scene of the Divine Providence and Management. Which, (as I have ſhewed it to Concern itſelf in other leſſer Things; ſo) we may preſume doth exert itſelf particularly in ſo Grand an Affair as that of Food, whereby the animal World ſubſiſts: And this will be manifeſted, and the *Pſalmiſt's* Obſervations exemplified, from theſe ſix following Particulars.

I. From the ſubſiſting and maintaining ſuch a large Number of Animals, throughout all Parts of the World.

II. From the proportionate Quantity of Food to the Eaters.

III. From the Variety of Food ſuited to the Variety of Animals: Or, the Delight which various Animals have in different Food.

IV. From the peculiar Food which peculiar Places afford to the Creatures ſuited to thoſe Places.

V. From the admirable and curious Apparatus made for the Gathering, Preparing, and Digeſtion of the Food. And,

VI. *and Laſtly,* From the great Sagacity of all Animals, in finding out and providing their Food.

I. It is a great Act of the Divine Power and Wiſdom, as well as Goodneſs, to provide Food for ſuch a World of Animals (*a*), as every where poſ-

ſeſs

(*a*) *Paſtum animantibus largè & copioſè natura eum, qui cuique aptus erat, comparavit.* Cic. de Nat. Deor. lib. ii. cap. 47.

Ille

ſeſs the Terraqueous Globe; on the dry Land; and in the Sea and Waters; in the Torrid and Frozen Zones, as well as the Temperate. That the temperate Climates, or at leaſt the fertile Valleys, and rich and plentiful Regions of the Earth, ſhould afford Subſiſtence to many Animals, may appear leſs wonderful perhaps: But that in all other the moſt likely Places for Supplies, ſufficient Food ſhould be afforded to ſuch a prodigious Number, and ſo great Variety of Beaſts, Birds, Fiſhes, and Inſects; is owing to that Being, who hath as wiſely adapted their Bodies to their Place and Food, as well as carefully provided Food for their Subſiſtence there.

But I ſhall leave this Conſideration, becauſe it will be illuſtrated under the following Points; and proceed,

II. To conſider the Adjuſtment of the Quantity of Food, in Proportion to the Eaters. In all Places there is generally enough; nay, ſuch a Sufficiency, as may be ſtiled a Plenty; but not ſuch a Superfluity, as to waſte and corrupt, and thereby annoy the World. But that which is particularly remarkable here, is, that among the great Variety of Foods, the moſt uſeful is the moſt plentiful, moſt univerſal, eaſieſt propagated, and moſt patient of Weather, and other Injuries. As the herbaceous Eaters (for Inſtance) are many, and devour much; ſo the Dry-Land Surface we find every where almoſt naturally carpeted over with Graſs, and other agreeable wholſome Plants; propagating themſelves in a manner every where, and ſcarcely deſtroyable by the Weather, the Plough, or any Art. So likewiſe for Grain, eſpecially ſuch as is moſt uſeful, how eaſily is it cultivated, and what a large Increaſe doth it

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Ille Deus eſt,— qui per totum orbem armenta dimiſit, qui gregibus ubique paſſim vagantibus pabulum præſtat. Senec. de Benef. lib. iv. cap. 6.

produce? *Pliny*'s Example of Wheat *(b)*, is a ſufficient Inſtance in this Matter; which (as that curious Heathen obſerves) being principally uſeful to the Support of Man, is eaſily propagated, and in great Plenty: And an happy Faculty that is of it, that it can bear either Extremes of Heat or Cold, ſo as ſcarce to refuſe any Clime.

III. Another wiſe Proviſion the Creator hath made relating to the Food of Animals, is, that various Animals delight in various Food *(c)*; ſome in Graſs and Herbs; ſome in Grain and Seeds; ſome in Fleſh; ſome in Inſects: ſome in this *(d)*; ſome in that; ſome more delicate and nice; ſome voracious and catching at any thing. If all delighted in, or ſubſiſted only with one Sort of Food, there would not be ſufficient for all; but every Variety chuſing various Food, and perhaps abhorring that which others like, is a great and wiſe Means that every Kind hath enough, and oftentimes ſomewhat to ſpare.

(b) Tritico nihil eſt fertilius: hoc ei natura tribuit, quoniam eo maximè alat hominem; utpote cùm è modio, ſi ſit aptum ſolum — 150 *modii reddantur. Miſit D. Auguſto procurator — ex uno grano (vix credibile dictu)* 400 *paucis minùs germina. Miſit & Neroni ſimiliter* 340 *ſtipulas ex uno grano.* Plin. Nat. Hiſt. lib. xviii. cap. 10.

(c) Sed illa quanta benignitas Naturæ, quòd tam multa ad veſcendum, tam varia, tam jucunda gignit; neque ea uno tempore anni, ut ſemper & novitate delectemur & copiâ. Cic. de Nat. Deor. lib. ii. cap. 53.

(d) Swammerdam obſerves of the *Ephemeron Worms*, that their Food is Clay, and that they make their Cells of the ſame. Upon which Occaſion he ſaith of *Moths*, that eat Wool and Fur, *There are two Things very conſiderable,* 1. *That the Cells they make to themſelves, wherein they live, and with which (as their Houſe, Tortoiſe-like) they move from Place to Place, they make of the Matter next at Hand.* 2. *That they feed alſo on the ſame, therefore when you find their Cells, or rather Coats or Caſes, to be made of yellow, green, blue, or black Cloth, you will alſo find their Dung of the ſame Colour.* Swam. Ephem. Vita, publiſhed by Dr. *Tyſon*, chap. 3.

It deſerves to be reckoned as an Act of the divine Appointment, that what is wholſome Food to one, is nauſeous, and as a Poiſon to another; what is a ſweet and delicate Smell and Taſte to one, is fœtid and loathſome to another: By which Means all the Proviſions the Globe affords are well diſpoſed of. Not only every Creature is well provided for, but a due Conſumption is made of thoſe Things that otherwiſe would encumber the World, lie in the Way, corrupt, rot, ſtink, and annoy, inſtead of cheriſhing and refreſhing it. For our moſt uſeful Plants, Grain, and Fruits, would mould and rot; thoſe Beaſts, Fowls, and Fiſhes, which are reckoned among the greateſt Dainties, would turn to Carrion, and poiſon us: Nay, thoſe Animals which are become Carrion, and many other Things that are noiſome, both on the Dry-Land, and in the Waters, would be great Annoyances, and breed Diſeaſes, was it not for the Proviſion which the infinite Orderer of the World hath made, by cauſing theſe Things to be ſweet, pleaſant, and wholeſome Food to ſome Creature or other, in the Place where thoſe Things fall: To Dogs, Ravens, and other voracious Animals, for Inſtance, on the Earth; and to rapacious Fiſhes, and other Creatures inhabiting the Waters.

Thus is the World, in ſome meaſure, kept ſweet and clean, and at the ſame time, divers Species of Animals ſupplied with convenient Food. Which Providence of GOD, particularly in the Supplies afforded the *Ravens*, is divers times taken Notice of in the Scriptures (*e*); but whether for the Reaſons now hinted, or any other ſpecial Reaſons, I ſhall not enquire. Thus our Saviour, *Luke* xii. 24. *Conſider the Ravens; for they neither ſow nor reap,*

(*e*) *Job* xxxviii. 41. *Pſal.* cxlvii. 9.

which neither have Storehouſe, nor Barn, and God feedeth them. It is a manifeſt Argument of the Divine Care and Providence, in ſupplying the World with Food and Neceſſaries, that the *Ravens*, accounted as unclean, and little regarded by Man, deſtitute of Stores, and that live by Accidents, by what falleth here and there; that ſuch a Bird, I ſay, ſhould be provided with ſufficient Food; eſpecially if that be true which *Ariſtotle (f)*, *Pliny (g)*, and *Ælian (h)* report, of their unatural Affection and Cruelty to their Young: "That they expel them "their Neſts as ſoon as they can fly, and then drive "them out of the Country."

Thus having conſidered the wiſe Appointment of the Creator, in ſuiting the Variety of Food, to Variety of Animals; Let us in the

IV. Place, Take a View of the peculiar Food, which particular Places afford to the Creatures inhabiting therein.

It hath been already obſerved *(i)*, That every Place on the Surface of the Terraqueous Globe, is ſtocked with proper Animals, whoſe Organs of Life and Action are curiouſly adapted to each reſpective Place. Now it is an admirable Act of the Divine Providence, That every Place affords a proper Food to all the living Creatures therein. All the various Regions of the World, the different Climates *(k)*, the various Soils, the Seas, the Waters,

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(f) Ariſtot. Hiſt. Animal. lib. ix. cap. 31.

(g) Pliny affirms this of the *Crow* as well as *Raven*: *Cæteræ omnes* [i. e. Cornices] *ex eodem genere pellunt nidis pullos, ac volare cogunt, ſicut & Corvi, qui — robuſtos ſuos fœtus fugant longiùs.* Nat. Hiſt. lib. x. cap. 12.

(h) Var. Hiſt.

(i) Chap. 9.

(k) Admiranda Naturæ diſpenſatio eſt, ut aliter, alioque modo, tempore, & induſtria colatur terra ſeptentrionalis, aliter Æthiopia, &c. Quoad Aquilonares, hoc certum eſt, in pleriſque agris Veſtrogothorum,

Waters, nay our very Putrefactions, and moſt naſty Places about the Globe, as they are inhabited by ſome or other Animal, ſo they produce ſome proper Food or other, affording a comfortable Subſiſtence to the Creatures living there. I might, for inſtances (*l*) of this, bring the great Variety of Herbs, Fruits and Grains on the Earth, the large Swarms of Inſects in the Air, with every other Food of the Creatures reſiding in the Earth, or flying in the Air. But I ſhall ſtop at the *Waters*, becauſe the *Pſalmiſt*, in the fore-cited civth *Pſalm*, ſpeaks with relation to the eſpecial Proviſion for the Inhabitants of the Waters; and alſo by Reaſon that many Land-Animals have their chief Maintenance from thence.

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gothorum, parte Objectâ Meridionali plagæ, Hordeum ſpatio 36 *Dierum à ſemine projecto maturum colligi, hoc eſt, à fine Junii uſque medium Auguſti, aliquando celerius. Ea namque maturitas ex ſoli naturâ, aëriſque clementiâ, ac humore lapillorum fovente radices, Soleque torrente, neceſſariò provenit, ut ita naſcatur, ac maturetur, taleſque ſpicæ ſex ordines in numero ariſtæ habent.* Ol. Mag. Hiſt. lib. 15. cap. 8. *Prata & paſcua tantâ luxuriant graminum ubertate ac diverſitate, ut neceſſum ſit inde arcere jumenta, ne nimio herbarum eſu crepent, &c.* Id. ib. lib. xix, cap. 36.

(*l*) Among the many noble Contrivances for Food, I cannot but attribute that univerſal Aliment, *Bread*, to the Revelation, or at leaſt the Inſpiration, of the Creator and Conſervator of Mankind; not only becauſe it is a Food uſed in all, or moſt Parts of the World, but eſpecially becauſe it is of incomparable Uſe in the great Work of Digeſtion, greatly aſſiſting the Ferment, or whatever cauſes the Digeſtion of the Stomach. Of which take this Example from the noble Mr. *Boyle*. "He extracted a *Menſtruum* from Bread alone, that would "work on Bodies more compact than many hard Minerals, "nay even on Glaſs itſelf, and do many Things that *Aqua-* "*fortis* could not do.—Yet by no means was this ſo corroſive "a Liquor as *Aqua-fortis*, or as the other *acid Menſtruum.*" *Vide* the ingenious and learned Dr. *Harris*'s *Lex. Tech. verbo Menſtruum*, where the Way of preparing it may be met with.

Now one would think, that the Waters were a very unlikely Element to produce Food for ſo great a Number of Creatures, as have their Subſiſtence from thence. But yet how rich a Promptuary is it, not only to large Multitudes of Fiſhes, but alſo to many amphibious Quadrupeds, Inſects, Reptiles, and Birds! From the largeſt *Leviathan*, which the *Pſalmiſt* ſaith *(m) playeth in the Seas*, to the ſmalleſt Mite in the Lakes and Ponds, all are plentifully provided for; as is manifeſt from the Fatneſs of their Bodies, and the Gaiety of their Aſpect and Actions.

And the Proviſion which the Creator hath made for this Service in the Waters is very obſervable; not only by the Germination of divers aquatick Plants there, but particularly by appointing the Waters to be the Matrix of many Animals, particularly of many of the Inſect-Kind, not only of ſuch as are peculiar to the Waters, but alſo of many appertaining to the Air and the Land, who, by their near Alliance to the Waters, delight to be about them, and by that Means become a Prey, and plentiful Food to the Inhabitants of the Waters. And beſides theſe, what prodigious Shoals do we find of minute Animals even ſometimes diſcolouring the Waters *(n)*! Of theſe (not only in

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(m) Pſal. civ. 26.

(n) The Inſects that for the moſt part diſcolour the Waters, are the ſmall Inſects of the *Shrimp-kind*, called by *Swammerdam*, *Pulex aquaticus arboreſcens*. Theſe I have often ſeen ſo numerous in ſtagnating Waters, in the Summer-Months, that they have changed the Colour of the Waters to a pale or deep Red, ſometimes a Yellow, according to the Colour they were of. Of this *Swammerdam* hath a pretty Story told him by Dr. *Florence Schuyl*, viz. *Se aliquando Studiis intentum, magno quodam & horrifico rumore fuiſſe turbatum, & ſimul ad cauſam ejus inquirendam excitatum; verùm ſe vix eum in finem ſurrexiſſe, cùm Ancilla ejus pœne exanimis adcurreret, & multo cum ſin-*

gultu

the Water, but in the Air and on Land) I have always thought there was ſome more than ordinary Uſe intended by the All-wiſe Creator. And having bent many of my Obſervations that Way, I have evidently found it accordingly to be. For be they never ſo numberleſs or minute, thoſe Animals ſerve for Food to ſome Creatures or other. Even thoſe Animalcules in the Waters, diſcoverable only with good Microſcopes, are a Repaſt to others there, as I have often with no leſs Admiration than Pleaſure ſeen *(o)*.

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gultu referret, omnem Lugduni [Batavorum] *aquam eſſe mutatam in ſanguinem.* The Cauſe of which, upon Examination, he found to be only from the numerous Swarms of thoſe *Pulices*. *Vide Swamm. Hiſt. Inſect.* p. 70.

The Cauſe of this great Concourſe and Appearance of thoſe little Inſects, I have frequently obſerved to be to perform their Coït, which is commonly about the latter End of *May*, and in *June*. At that Time they are very venerous, friſking and catching at one another; and many of them conjoined Tail to Tail, with their Bellies inclined one towards another.

At this Time alſo they change their Skin or *Slough*; which I conceive their rubbing againſt one another mightily promoteth. And what if at this Time they change their Quarters? *Vide Book* VIII. *Chap.* iv. *Note (f).*

Theſe ſmall Inſects, as they are very numerous, ſo are Food to many Water-Animals. I have ſeen not only *Ducks* ſhovel them up as they ſwim along the Waters, but divers Inſects alſo devour them, particularly ſome of the middle-ſized *Squillæ aquaticæ*, which are very voracious Inſects.

(o) Beſides the *Pulices* laſt mentioned, there are in the Waters other Animalcules very numerous, which are ſcarce viſible without a Microſcope. In *May*, and the Summer-Months, the green Scum on the Top of ſtagnating Waters, is nothing elſe but prodigious Numbers of theſe Animalcules: So is likewiſe the green Colour in them, when all the Water ſeems green. Which Animalcules, in all Probability, ſerve for Food to the *Pulices Aquatici*, and other the minuter Animals of the Waters. Of which I gave a pregnant Inſtance in one of the *Nymphæ* of *Gnats*, to my Friend the late admirable Mr. *Ray*, which he was pleaſed to publiſh in the laſt Edition of his *Wiſdom of God in the Creation*, p. 430.

But now the uſual Objection is, that Neceſſity maketh Uſe (*p*). Animals muſt be fed, and they make uſe of what they find: In the deſolate Regions, and in the Waters, for Inſtance, they feed upon what they can come at; but, when in greater Plenty, they pick and chuſe.

But this Objection hath been already in ſome Meaſure anſwered by what hath been ſaid; which

plainly

(*p*) *Nil adeò quoniam natum'ſt in Corpore, ututi*
Poſſemus, ſed quod natum'ſt, id procreat uſum.

And afterwards,

Propterea capitur Cibus, ut ſuffulciat artus,
Et recreet vireis interdatus, atque patentem
Per membra ac venas ut amorem obturet edendi.

And after the ſame Manner he diſcourſeth of Thirſt, and divers other Things. *Vide Lucret.* lib. iv. ver. 831; &c.

Againſt this Opinion of the *Epicureans*, *Galen* ingeniouſly argues in his Diſcourſe about the Hand. *Non enim Manus ipſæ* (ſaith he) *homines artes docuerunt, ſed Ratio. Manus autem ipſæ ſunt artium organa; ſicut Lyra muſici — Lyra muſicam non docuit, ſed eſt ipſius artifex per eam, quâ præditus eſt, Rationem; agere autem non poteſt ex arte abſque organis, ita & una quælibet anima facultates quaſdam à ſuâ ipſius ſubſtantiâ obtinet, — Quòd autem corporis particulæ animam non impellunt, — manifeſtè videre licet, ſi animalia recens nata conſideret, quæ quidem priùs agere conantur, quàm perfectas habeant particulas. Ego namque Bovis vitulum cornibus petere conantem ſæpenumero vidi, antequam ei nata eſſent cornua; Et pullum Equi calcitrantem, &c. Omne enim animal ſuæ ipſius Animæ facultates, ac in quos uſus partes ſuæ polleant maximè, nullo doctore, præſentit — Quâ igitur ratione dici poteſt, animalia partium uſus à partibus doceri, cùm & antequam illas habeant, hoc cognoſcere videantur? Si igitur Ova tria acceperis, unum Aquilæ, alterum Anatis, reliquum Serpentis, & calore modico foveris, animaliaque excluſeris; illa quidem alis volare conantia, antequàm volare poſſint; hæc autem revolvi videbis, & ſerpere affectans, quamvis molle adhuc & invalidum fuerit. Et ſi, dum perfecta erunt, in unâ eâdemque domo nutriveris, deinde ad locum ſubdialem ducta emiſeris, Aquila quidem ad ſublime; Anas autem in paludem; — Serpens verò ſub terrâ irrepet — Animalia quidem mihi videntur Naturâ magis quàm Ratione artem aliquam* [τεχνικὰ artificioſa] *exercere: Apes fingere alveolos*, &c. Galen. de Uſu Part. cap. 3.

plainly argues Deſign, and a ſuper-intending Wiſdom, Power and Providence in this ſpecial Buſineſs of Food. Particularly the different Delight of divers Animals in different Food, ſo that what is nauſeous to one, ſhould be Dainties to another, is a manifeſt Argument, that the Allotment of Food is not a Matter of mere Chance, but entailed to the very Conſtitution and Nature of Animals; that they chuſe this, and refuſe that, not by Accident, or Neceſſity, but becauſe the one is a proper Food, agreeable to their Conſtitution, and ſo appointed by the infinite Contriver of their Bodies; and the other is diſagreeable and injurious to them.

But all this Objection will be found frivolous, and the Wiſdom and Deſign of the great Creator will demonſtratively appear, if we take a Survey,

V. Of the admirable and curious Apparatus in all Animals, made for the Gathering, Preparing, and Digeſtion of their Food. From the very firſt Entrance, to the utmoſt Exit of the Food, we find every Thing contrived, made and diſpoſed with the utmoſt Dexterity and Art, and curiouſly adapted to the Place the Animal liveth in, and the Food it is to be nouriſhed with.

Let us begin with the *Mouth*. And this we find, in every Species of Animals, nicely conformable to the Uſe of ſuch a Part; neatly ſized and ſhaped for the catching of Prey, for the gathering or receiving Food (q), for the Formation of Speech, and every other ſuch like Uſe *(r)*. In ſome Creatures it is wide and large, in ſome little and narrow; in ſome with a deep Inciſure up into the Head *(s)*, for the better catching and holding of Prey, and more eaſy Comminution of hard, large and troubleſome Food; in others with a much ſhorter Inciſure, for the gathering and holding of herbaceous Food.

(q) *Alia dentibus prædantur, alia unguibus, alia roſtri aduncitate carpunt, alia latitudine* [ejuſdem] *ruunt, alia acumine excavant, alia ſugunt, alia lambunt, ſorbent, mandunt, vorant. Nec minor varietas in pedum miniſterio, ut rapiant, diſtrahant, teneant, premant, pendeant, tellurem ſcabere non ceſſent.* Plin. Nat. Hiſt. lib. x. cap. 71.

In *Inſects* it is very notable. In ſome forcipated, to catch hold and tear their Prey *(t)*: In ſome acu-

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(r) Becauſe it would be tedious to reckon up the Bones, Glands, Muſcles, and other Parts belonging to the Mouth, it ſhall ſuffice to obſerve, that, for the various Services of Man's Mouth, beſides the Muſcles in common with other Parts, there are five Pair, and one ſingle one proper to the Lips only, as Dr. *Gibſon* reckons them: But my moſt diligent and curious Friend the late Mr. *Cowper*, diſcovered a ſixth Pair. And accordingly Dr. *Drake* reckons ſix Pair, and one ſingle one proper to the Lips. Lib. iii. cap. 13.

(s) Galen deſerves to be here conſulted, who excellently argues againſt the caſual Concourſe of the Atoms of *Epicurus* and *Aſclepiades*, from the provident and wiſe Formation of the Mouths of Animals, and their Teeth anſwerable thereto. In Man, his Mouth without a deep Inciſure, with only one canine Tooth on a Side, and flat Nails, becauſe, ſaith he, *Hic Natura certò ſciebat, ſe animal manſuetum, ac civile effingere, cui robur & vires eſſent ex ſapientiâ, non ex corporis fortitudine.* But for *Lions*, *Wolves*, and *Dogs*, and all ſuch as are called Καρχαρόδοντες (or having ſharp, ſerrated Teeth), their Mouths are large, and deep cut; Teeth ſtrong and ſharp, and their Nails ſharp, large, ſtrong, and round, accommodated to holding and tearing. *Vide Galen. de Uſ. Part.* lib. xi. cap. 9.

(t) Among Inſects, the *Squillæ aquaticæ*, as they are very rapacious, ſo are accordingly provided for it: Particularly the *Squilla aquatica maxima recurva* (as I call it) who hath ſomewhat terrible in its very Aſpect, and in its Poſture in the Water, eſpecially its Mouth, which is armed with long, ſharp Hooks, with which it boldly, and greedily, catcheth any Thing in the Waters, even one's Fingers. When they have ſeized their Prey, they will ſo tenaciouſly hold it with their forcipated Mouth, that they will not part therewith, even when they are taken out of the Waters, and jumbled about

aculeated, to pierce and wound Animals *(u)*, and ſuck their Blood. And in others ſtrongly rigged with Jaws and Teeth, to gnaw and ſcrape out their Food, to carry Burdens *(w)*, to perforate the Earth, yea, the hardeſt Wood, yea, even Stones themſelves,

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about in one's Hand. I have admired at their peculiar Way of taking in their Food; which is done by piercing their Prey with their *Forcipes* (which are hollow) and ſucking the Juice thereof through them.

The *Squilla* here mentioned, is the firſt and ſecond in *Mouffet's Theat. Inſect.* lib. ii. cap. 37.

(u) For an Inſtance of Inſects endued with a Spear, I ſhall, for its Peculiarity, pitch upon one of the ſmalleſt, if not the very ſmalleſt, of all the *Gnat* Kind, which I call *Culex minimus nigricans maculatus ſanguiſuga.* Among us in *Eſſex*, they are called *Nidiots*; by *Mouffet*, *Midges.* It is about one tenth of an Inch, or ſomewhat more, long, with ſhort *Antennæ*, plain in the Female, in the Male feathered, ſomewhat like a Bottle-Bruſh. It is ſpotted with blackiſh Spots, eſpecially on the Wings, which extend a little beyond the Body. It comes from a little ſlender Eel-like Worm of a dirty white Colour, ſwimming in ſtagnating Waters by a wriggling Motion; as in *Fig.* 5.

Its *Aurelia* is ſmall, with a black Head, little ſhort Horns, a ſpotted, ſlender, rough Belly. *Vide Fig.* 6. It lies quietly on the Top of the Water, now and then gently wagging itſelf this Way and that.

Theſe *Gnats* are greedy Blood-ſuckers, and very troubleſome, where numerous; as they are in ſome Places near the *Thames*, particularly in the Breach-Waters, that have lately befallen near us, in the Pariſh of *Dagenham*; where I found them ſo vexatious, that I was glad to get out of thoſe Marſhes. Yea, I have ſeen Horſes ſo ſtung with them, that they have had Drops of Blood all over their Bodies, where they were wounded by them.

I have given a Figure (in *Fig.* 7.) and more particular Deſcription of the *Gnats*, becauſe, although it be common, it is no where taken Notice of by any Author I know, except *Mouffet*, who, I ſuppoſe, means theſe *Gnats*, which he calls *Midges*, cap. 13. p. 82.

(w) Hornets and *Waſps* have ſtrong Jaws, toothed, wherewith they can dig into Fruits, for their Food; as alſo gnaw and ſcrape Wood, whole Mouthfuls of which they carry away to make their Combs. *Vide infra, Chap.* xiii. *Note (c).*

for Houſes *(x)* to themſelves, and Neſts for their Young.

And laſtly, in *Birds* it is no leſs remarkable. In the firſt Place, it is neatly ſhaped for piercing the Air, and making Way for the Body through the airy Regions. In the next Place, it is hard and horny, which is a good Supplement for the Want of Teeth, and cauſeth the Bill to have the Uſe and Service of the Hand. Its hooked Form is of great Uſe to the rapacious Kind *(y)*, in catching and holding their Prey, and in the Comminution thereof by tearing; to others it is no leſs ſerviceable to their Climbing, as well as neat and nice Comminution of their Food *(z)*. Its extraordinary Length and Slenderneſs is very uſeful to ſome, to ſearch and grope for their Food in mooriſh Places *(aa)*; as its Length and Breadth is to others to hunt and

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(x) Monſieur *de la Voye* tells us of an ancient Wall of Free-Stone in the *Benedictines Abbey* at *Caen*, in *Normandy*, ſo eaten with Worms, that one may run one's Hand into moſt of the Cavities: That theſe Worms are ſmall and black, lodging in a greyiſh Shell; that they have large flattiſh Heads, a large Mouth, with four black Jaws, *&c.* *Philoſ. Tranſact.* N° 18.

(y) Pro iis [Labris] *cornea & acuta Volucribus Roſtra. Eadem rapto viventibus adunca: collecto, recta: berbas ruentibus limumque lata, ut Suum generi. Jumentis vici manûs ad colligenda pabula: ora apertiora laniatu viventibus.* Plin. Nat. Hiſt. lib. xi. cap. 37.

(z) Parrots have their Bills nicely adapted to theſe Services, being hooked, for climbing and reaching what they have Occaſion for; and the lower Jaw being completely fitted to the Hooks of the upper, they can as minutely break their Food, as other Animals do with their Teeth.

(aa) Thus in *Woodcocks*, *Snipes*, &c. who hunt for Worms in mooriſh Ground, and, as Mr. *Willoughby* ſaith, live alſo on the fatty unctuous Humour they ſuck out of the Earth. So alſo the Bills of *Curlews*, and many other Sea-Fowl, are very long, to enable them to hunt for the Worms, *&c.* in the Sands on the Sea-Shore, which they frequent.

ſearch in muddy Places *(bb)*: And the contrary Form, namely, a thick, ſhort, and ſharp edged Bill, is as uſeful to other Birds, who have Occaſion to huſk and flay the Grains they ſwallow. But it would be endleſs, and tedious, to reckon up all the various Shapes, and commodious Mechaniſm of all; the Sharpneſs and Strength of thoſe who have occaſion to perforate Wood and Shells *(cc)*; the Slenderneſs and Neatneſs of ſuch as pick up ſmall Inſects; the Croſs-Form of ſuch as break up Fruits *(dd)*; the compreſſed Form of others *(ee)*, with many other curious and artificial Forms, all ſuited to the Way of Living, and peculiar Occaſions of the ſeveral Species of Birds. Thus much for the Mouth.

Let us next take a ſhort View of the *Teeth (ff)*, In

(bb) *Ducks*, *Geeſe*, and divers others, have ſuch long broad Bills, to quaffer and hunt in Water and Mud; to which we may reckon the uncouth Bill of the *Spoon-Bill:* But that which deſerves particular Obſervation in the Birds named in theſe two laſt Notes is, the Nerves going to the End of their Bills, enabling them to diſcover their Food out of Sight; of which ſee *Book* VII. *Chap.* ii. *Note (e).*

(cc) The *Picus Viridis*, or *Green Woodſpite*, and all the *Wood-Peckers*, have Bills curiouſly made for digging Wood, ſtrong, hard, and ſharp. A neat Ridge runs along the Top of the green *Wood-Pecker*'s Bill, as if an Artiſt had deſigned it for Strength and Neatneſs.

(dd) The *Loxia*, or *Croſs-Bill*, whoſe Bill is thick and ſtrong, with the Tips croſſing one another, with great Readineſs breaks open Fir-Cones, Apples, and other Fruit, to come at their Kernels, which are its Food, as if the croſſing of the Bill was deſigned for this Service.

(ee) The *Sea-Pie* hath a long, ſharp, narrow Bill, compreſſed ſide-ways, and every Way ſo well adapted to the raiſing *Limpets* from the Rocks (which are its chief, if not only Food) that Nature (or rather the Author of Nature) ſeems to have framed it purely for that Uſe.

(ff) Thoſe Animals which have Teeth on both Jaws, have but one Stomach; but moſt of thoſe which have no upper Teeth, or none at all, have three Stomachs; as in Beaſts, the Paunch, the

In which their peculiar Hardneſs *(gg)* is remarkable, their Growth *(hh)* alſo, their firſt Inſertion and Bandage in the Gums and Jaws, and their various Shape and Strength, ſuited to their various Occaſion and Uſe *(ii)*; the foremoſt weak and fartheſt from the Center, as being only Preparers to the reſt; the others being to grind and mince, are accordingly made ſtronger, and placed nearer the

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Read, and the Feek; *and in all granivorous Birds, the Crop, the Echinus, and the Gizard. For as chewing is to an eaſy Digeſtion, ſo is ſwallowing whole to that which is more laborious.* Dr. *Grew*'s Coſmol. Sacr. cap. v. ſect. 24.

(gg) J. Peyer ſaith, the Teeth are made of convolved Skins hardened; and if we view the Grinders of *Deer, Horſes, Sheep, &c.* we ſhall find great Reaſon to be of his Mind. His Obſervations are, *Mirum autem eos* (i. e. *Dentes cùm primùm è pelliculis imbricatim convolutis & muco viſcido conſtarent, in tantam dirigeſcere ſoliditatem, quæ oſſa cuncta ſuperet. Idem fit etiam in Oſſiculis Ceraſorum, &c. — Separatione factâ, per membranas conditur Magna locellis, quos formant laminæ tenus, ac duriuſcula ad dentis figuram anteà divinitùs compoſitæ.* J. Peyer Merycol. lib. ii. cap. 8.

(hh) Qui autem (i. e. *Dentes) renaſcuntur, minimè credendi ſunt à facultate aliquâ plaſticâ Brutorum denuò formari, ſed latentes tantummodo in conſpectum producuntur augmento molis effluente ſucco.* Id. ibid.

(ii) From theſe, and other like Conſiderations of the Teeth, *Galen* infers, That they muſt needs be the Work of ſome wiſe, provident *Being*; not *Chance*, nor a fortuitous Concourſe of *Atoms*. For the Confirmation of which, he puts the Caſe, That ſuppoſe the Order of the Teeth ſhould have been inverted, the *Grinders* ſet in the Room of the *Inciſors, &c.* (which might as well have been, had not the Teeth been placed by a wiſe Agent) in this Caſe, What Uſe would the Teeth have been of? What Confuſion by ſuch a ſlight Error in their Diſpoſal only? Upon which he argues, *At ſi quis choream hominum* 32 (the Number of the Teeth) *ordine diſpoſuit, eum ut hominem induſtrium laudaremus*; *cùm verò Dentium choream Natura tam bellè exornârit, nonne ipſam quoque laudabimus?* And then he goes on with the Argument, from the Sockets of the Teeth, and their nice fitting in them, which being no leſs accurately done, than what is done by a Carpenter, or Stone-Cutter, in fitting a Tenon into a Mortice, doth as

the Center of Motion and Strength. Likewiſe their various Form *(kk)* in various Animals, is conſiderable, being all curiouſly adapted to the peculiar Food *(ll)*, and Occaſions of the ſeveral Species of Animals *(mm)*. And laſtly, the temporary Defect of them *(nn)*, is no leſs obſervable in Children, and

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as well infer the Art and Act of the wiſe *Maker* of Animal Bodies, as the other doth the Act and Art of Man. And ſo he goes on with other Arguments to the ſame Effect. *Galen de Uſ. Part.* lib. xi. chap. 8.

(kk) A curious Account of this may be found in an *Extract of a Letter concerning the Teeth of divers Animals.* Printed at *Paris*, in *M. Vaugnion*'s Complete Body of Chirurg. Oper. Chap. 53.

(ll) As it hath been taken Notice of, that various Animals delight in various Food, ſo it conſtantly falls out, that their Teeth are accordingly fitted to their Food; the Rapacious to catching, holding, and tearing their Prey; the Herbaceous to Gathering and Comminution of Vegetables: And ſuch as have no Teeth, as Birds, their Bill, Craw, and Gizard, are aſſiſted with Stones, to ſupply the Defect of Teeth. But the moſt conſiderable Example of this Kind is in ſome Families of the Inſect-Tribes, as the *Papillio Kind*, &c. who have Teeth, and are voracious, and live on tender Vegetables in their *Nympha* or *Caterpillar-State*, when they can only creep; but in their mature *Papillio-State*, they have no Teeth, but a *Proboſcis*, or *Trunk*, to ſuck up Honey, &c. their Parts for gathering Food, as well as their Food, being changed, as ſoon as they have Wings to enable them to fly to it.

(mm) It is remarkable in the Teeth of Fiſhes, that in ſome they are ſharp, as alſo jointed ſo as to fall back, the better to catch and hold their Prey, and to facilitate its Paſſage into the Stomach: So in others they are broad and flat, made to break the Shells of Snails and Shell-Fiſh devoured by them. Theſe *Teeth*, or *Breakers*, are placed, in ſome, in the Mouth; in ſome, in the Throat; and in *Lobſters*, &c. in the Stomach itſelf, in the Bottom of whoſe Stomachs are three of thoſe *Grinders*, with peculiar Muſcles to move them.

(nn) What is there in the World can be called an Act of Providence and Deſign, if this temporary Defect of Teeth be not ſuch? That Children, for Inſtance, ſhould have none whilſt they are not able to uſe them, but to hurt themſelves, or the Mother; and that at the very Age when they can take in

and ſuch young Creatures, where there is no Occaſion for them; but they would be rather an Annoyance to the tender Nipples and Breaſts.

From the Teeth, the grand Inſtruments of Maſtication, let us proceed to the other miniſterial Parts. And here the *Parotid*, *Sublingual*, and *maxillary Glands*, together with thoſe of the Cheeks and Lips, are conſiderable; all lodged in the moſt convenient Places about the Mouth and Throat, to afford that noble digeſtive ſalival Liquor, to be mixed with the Food in Maſtication, and to moiſten and lubricate the Paſſages, to give an eaſy deſcent to the Food. The commodious Form alſo of the Jaws, deſerves our Notice; together with the ſtrong Articulation of the lowermoſt, and its Motion. And laſtly, the curious Form, the great Strength, the convenient Lodgment and Situation of the ſeveral Muſcles and Tendons *(oo)*, all miniſtring to this ſo neceſſary an Act of Life, as Maſtication is; they are ſuch Contrivances, ſuch Works, as plainly ſet forth the infinite Workman's Care and Skill.

Next to the Mouth, the *Gullet* preſenteth itſelf; in every Creature well-ſized to the Food it hath occaſion to ſwallow; in ſome but narrow, in others,

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in more ſubſtantial Food, and live without the Breaſt, and begin to need Teeth, for the ſake of Speech; that then, I ſay, their Teeth ſhould begin to appear, and gradually grow, as they more and more ſtand in need of them.

(oo) It would be endleſs to particularize here, and therefore I ſhall refer to the Anatomiſts; among the reſt, particularly to *Galen*, for the ſake of his Deſcant upon this Subject. For having deſcribed the great Accuracy of the Contrivance and Make of theſe Parts, he ſaith, *Haud ſcio an hominum ſit ſobriorum ad Fortunam opificem id revocare: alioqui quid tandem erit, quod cum Providentiâ atque Arte efficitur? Omnino enim hoc ei contrarium eſſe debet, quod caſu ac fortuito fit.* Galen. de Uſ. Part. lib. xi. cap. 7. ubi plura.

as large and extenſive *(pp)*; in all exceedingly remarkable for the curious Mechaniſm of its Muſcles, and the artificial Decuſſation and Poſition of their Fibres *(qq)*.

And now we are arrived to the grand Receptacle of the Food, the *Stomach*; for the moſt part as various as the Food to be conveyed therein. And here I might deſcribe the admirable Mechaniſm of its Tunicks, Muſcles, Glands, the Nerves, Arteries, and Veins *(rr)*; all manifeſting the ſuper-eminent Contrivance and Art of the infinite

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(pp) The Bore of the Gullet is not in all Creatures alike anſwerable to the Body or Stomach. As in the Fox, *which both feeds on Bones, and ſwallows whole, or with little chewing; add next in a* Dog, *and other oſſivorous Quadrupeds, it is very large,* viz. *to prevent a Contuſion therein. Next in a* Horſe, *which though he feeds on Graſs, yet ſwallows much at once, and ſo requires a more open Paſſage. But in a* Sheep, Rabbit, *or* Ox, *which bite ſhort, and ſwallow leſs at once, it is ſmaller. And in a* Squirrel, *ſtill leſſer, both becauſe he eats fine, and to keep him from diſgorging his Meat upon his deſcending Leaps. And ſo in* Rats *and* Mice, *which often run along Walls, with their Heads downwards.* Dr. *Grew*'s Comp. Anat. of Stom. and Guts, chap. 5.

(qq) Of this ſee Dr. *Willis's Pharm. Rat.* part i. ſect. i. cap. 2. *Steno* alſo, and *Peyer. Mery.* lib. ii.

The Deſcription theſe give of the muſcular Part of the Gullet, the late ingenious and learned Dr. *Drake* ſaith, is very exact in Ruminants, but not in Men. *In Men, this Coat* (the ſecond of the Gullet) *conſiſts of two fleſhy* Lamellæ, *like two diſtinct Muſcles. The outward being compoſed of ſtrait longitudinal Fibres. — The inner Order of Fibres is annular, without any obſervable Angles. — The Uſe of this Coat, and theſe Orders of Fibres, is to promote Deglutition; of which the Longitudinal — ſhorten the* Oeſophagus, *and ſo make its Capacity larger, to admit of the Matter to be ſwallowed. The Annular, on the contrary, contract the Capacity, and cloſing behind the deſcending Aliment, preſs it downwards.* Drake's *Anat.* vol. i. lib. i. cap. 9.

(rr) See *Willis*, ibid. *Cowper*'s *Anat. Tab.* 35. and many other Authors.

Workman (*ss*); they being all nicely adjuſted to their reſpective Place, Occaſion, and Service. I might alſo inſiſt upon that moſt neceſſary Office of *Digeſtion*; and here conſider that wonderful Faculty of the Stomachs of all Creatures, to diſſolve (*tt*) all the ſeveral Sorts of Food appropriated to their Species; even ſometimes Things of that Conſiſtency as ſeem inſoluble (*uu*); eſpecially by ſuch ſeemingly ſimple and weak *Menſtruums* as we find in their Stomachs: But I ſhall only give theſe Things a bare Mention, and take more peculiar Notice of the ſpecial Proviſion made in the particular Species of Animals, for the Digeſtion of that ſpecial Food appointed them.

(*ss*) *Promptuarium autem hoc, alimentum univerſum excipiens, ceu Divinum, non Humanum ſit opificium.* Galen. de Uſ. Part. lib. iv. cap. 1.

(*tt*) *How great a Comprehenſion of the Nature of Things, did it require to make a* Menſtruum, *that ſhould corrode all Sorts of Fleſh coming into the Stomach, and yet not the Stomach itſelf, which is alſo Fleſh?* Dr. *Grew*'s Coſmol. Sacr. cap. 4.

(*uu*) The Food of the *Caſtor* being oftentimes, if not always, dry Things, and hard of Digeſtion, ſuch as the Roots and Bark of Trees, it is a wonderful Proviſion made in that Creature's Stomach, by the digeſtive Juice lodged in the curious little Cells there. A Deſcription of whoſe admirable Structure and Order may be found in *Blaſius* from *Wepfer*: concerning which he ſaith, *In quibus Mucus reconditus, non ſecus ac Mel in Favis.—Nimirum quia Caſtoris alimentum exſuccum, & coctu difficillimum eſt, ſapientiſſimus & ſummè admirandus in ſuis operibus rerum Conditor, D. O. M. ipſi pulcherrimâ iſtâ & affabrè factâ ſtructurâ benigniſſimè proſpexit, ut nunquam deeſſet Fermentum, quod ad ſolvendum, & comminuendum alimentum durum & aſperum par foret.* Vide Blaſ. Anat. Animal. cap. 10. *Confer etiam* Act. Erud. Lipſ. Ann. 1684. p. 360.

Moſt of our modern Anatomiſts and Phyſicians attribute Digeſtion to a diſſolving *Menſtruum*; but Dr. *Drake* takes it to be rather from fermentative, diſſolving Principles in the Aliment itſelf, with the Concurrence of the Air and Heat of the Body; as in Dr. *Papin's Digeſter. Vide Dr. Anat.* vol. i. cap. 14.

And in the firſt Place it is obſervable, that, in every Species of Animals, the Strength and Size of their Stomach *(ww)* is conformable to their Food. Such whoſe Food is more delicate, tender, and nutritive, have commonly this Part thinner, weaker, and leſs bulky; whereas ſuch whoſe Aliment is leſs nutritive, or whoſe Bodies require larger Supplies to anſwer their Bulk, their Labours, and waſte of Strength and Spirits, in them it is large and ſtrong.

Another very remarkable Thing in this Part, is, the Number of Ventricles in divers Creatures. In many but one; in ſome two or more *(xx)*. In ſuch as make a ſufficient Comminution of the Food in the Mouth, one ſuffices. But where Teeth are wanting, and the Food dry and hard, (as in granivorous Birds), there the Defect is abundantly ſupplied by one thin membranaceous Ventricle, to receive and moiſten the Food, and another thick, ſtrong, muſcular one, to grind and tear *(yy)* it. But in ſuch Birds, and other Creatures,

whoſe

(ww) All carnivorous Quadrupeds have the ſmalleſt Ventricles, Fleſh going fartheſt. Thoſe that feed on Fruits, and Roots, have them of a Middle Size. Yet the Mole, *becauſe it feeds unclean, hath a very great one.* Sheep *and* Oxen, *which feed on Graſs, have the greateſt. Yet the* Horſe *(and for the ſame Reaſon the* Coney *and* Hare) *though Graminivorous, yet comparatively hath but little ones. For that a* Horſe *is made for Labour, and both this, and the* Hare, *for quick and continued Motion; for which, the moſt eaſy Reſpiration, and ſo the freeſt Motion of the Diaphragm, is very requiſite; which yet could not be, ſhould the Stomach lie big and cumberſome upon it, as in* Sheep *and* Oxen *it doth.* Grew ib. chap. 6.

(xx) The *Dromedary* hath four Stomachs, one whereof is peculiarly endowed with about twenty Cavities, like Sacks, in all Probability for the holding of Water. Concerning which, ſee *Book* VI. *Chap.* iv. *Note (a).*

(yy) To aſſiſt in which Office, they ſwallow ſmall angular Stones, which are to be met with in the Gizards of all gra-

nivorous

whoſe Food is not Grain, but Fleſh, Fruits, Inſects, or partly one, partly the other, there their Stomachs are accordingly conformable to their Food *(zz)*, ſtronger or weaker, membranaceous or muſcular.

But as remarkable a Thing as any in this Part of Animals, is, the curious Contrivance and Fabrick of the ſeveral Ventricles of ruminating Creatures. The very Act itſelf of *Rumination*, is an excellent Proviſion for the complete Maſtication of the Food, at the Reſting, leiſure Times of the Animal. But the Apparatus for this Service, of divers Ventricles for its various Uſes and Purpoſes, together with their curious Mechaniſm, deſerves great Admiration *(aaa)*.

Having thus far purſued the Food to the Place, where, by its Reduction into Chyle, it becomes a proper Aliment for the Body; I might next trace it through the ſeveral Mæanders of the *Guts*, the *Lacteals*, and ſo into the *Blood (bbb)*, and afterwards

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nivorous Birds; but in the Gizard of the *Iynx*, or *Wryneck*, which was full only of *Ants*, I found not one Stone. So in that of the *Green Wood-Pecker*, (full of *Ants* and Tree-Maggots) there were but few Stones.

(zz) In moſt carnivorous Birds, the third Ventricle is Membranous; where the Meat is concocted, as in a Man: Or ſomewhat Tendinous, as in an Owl; *as if it were made indifferently for Fleſh, or other Meat, as he could meet with either: Or moſt thick and tendinous, called the Gizard; wherein the Meat, as on a Mill, is ground to Pieces.* Grew, ubi ſupra, chap. 9.

(aaa) It would be much too long a Taſk to inſiſt upon it here as it deſerves, and therefore concerning the whole Buſineſs of Rumination, I ſhall refer to *J. Conr. Peyeri Merycolog. ſeu de Ruminantibus & Ruminatione Commentar.* where he largely treateth of the ſeveral Ruminating Animals, of the Parts miniſtring to this Act, and the great Uſe and Benefit thereof unto them.

(bbb) There are too many Particulars to be inſiſted on, obſervable in the Paſſages of the *Chyle*, from the Guts to the *Left*

wards into the very Habit of the Body: I might alſo take Notice of the Separation made in the *Inteſtines*, of what is nutritive, (which is received,) and what is feculent, (being ejected;) and the Impregnations there from the *Pancreas* and the *Gall*; and after it hath been ſtrained through thoſe curious Colanders, the *lacteal Veins*, I might alſo obſerve its Impregnations from the *Glands* and *Lymphæducts*; and, to name no more, I might farther view the exquiſite Structure of the Parts miniſtring to all theſe delicate Offices of Nature;

Left Subclavian Vein, where it enters into the Blood; and therefore I ſhall only, for a Sample of this admirable Œconomy, take Notice of ſome of the main and more general Matters. And,

1. After the Food is become Chyle, and gotten into the Guts, it is an excellent Proviſion made, not only for its Paſſage through the Guts, but alſo for its Protruſion into the *Lacteals* by the *Periſtaltick* Motion, and *Valvulæ Conniventes* of the Guts. 2. It is an admirable Proviſion, that the Mouths of the *Lacteals*, and indeed the *Lacteals primi generis* themſelves, are ſmall and fine, not wider than the *Capillary Arteries* are, leſt by admitting Particles of the Nouriſhment groſſer than the *Capillaries*, dangerous Obſtructions might be thereby produced. 3. After the Reception of the Aliment into the *Lacteals primi generis*, it is a noble Proviſion for the Advancement of its Motion, that in the *Meſenterick Glands*, it meets with ſome of the *Lymphæ-Ducts*, and receives the Impregnation of the *Lympha*. And paſſing on from thence, it is no leſs an Advantage, 4. That the *Lacteals*, and *Lymphæ Ducts* meet in the *Receptaculum Chyli*, where the Aliment meeting with more of the *Lympha*, is made of a due Conſiſtence and Temperament, for its farther Advancement through the *Thoracic Duct*, and ſo into the *Left Subclavian Vein* and Blood. Laſtly, This *Thoracic Duct* itſelf is a Part of great Conſideration. For (as Mr. *Cowper* ſaith) *If we conſider in this Duct its ſeveral Diviſions and Inoſculations, its numerous Valves looking from below upwards, its advantageous Situation between the great Artery and* Vertebræ *of the Back, together with the Ducts diſcharging their refluent* Lympha *from the Lungs, and other neighbouring Parts, we ſhall find all conduce to demonſtrate the utmoſt Art of Nature uſed in furthering the ſteep and perpendicular Aſcent of the Chyle.* Anat. Introduct.

particularly the artificial Conformation of the Inteſtines might deſerve a ſpecial Enquiry, their Tunicks, Glands, Fibres traverſing one another *(ccc)*, and periſtaltick Motion in all Creatures; and their cochleous Paſſage *(ddd)* to retard the Motion of the Chyle, and to make amends for the Shortneſs of the Inteſtines, in ſuch Creatures who have but one Gut; together with many other Accommodations of Nature in particular Animals that might be mentioned. But it ſhall ſuffice to have given only a general Hint of thoſe curious and admirable Works of God. From whence it is abundantly manifeſt, how little Weight there is in the former atheiſtical Objection. Which will receive a further Confutation from the

VI. and laſt Thing relating to Food, that I ſhall ſpeak of, namely, *The great Sagacity of all Animals, in finding out and providing their Food.* In Man, perhaps, we may not find any Thing very admirable, or remarkable in tihs Kind, by Means of his Reaſon and Underſtanding, and his Supremacy over the inferior Creatures; which anſwereth all his Occaſions relating to this Buſineſs: But then even here

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(ccc) Theſe, although noble Contrivances and Works of God, are too many to be inſiſted on, and therefore I ſhall refer to the Anatomiſts, particularly Dr. *Willis Pharmaceut.* Dr. *Cole*, in *Phil. Tranſ.* N° 125. and Mr. *Cowper*'s elegant Cut in *Anat. Tab.* 34, 35. and *Append. Fig.* 39, 40.

(ddd) In the *Thornback*, and ſome other Fiſhes, it is a very curious Proviſion that is made to ſupply the Paucity and Brevity of the Guts; by the Perforation of their ſingle Gut, going out ſtrait along, but round like a Pair of Winding-Stairs: ſo that their Gut, which ſeems to be but a few Inches long, hath really a Bore of many Inches. But of theſe, and many other noble Curioſities and Diſcoveries in Anatomy, the Reader, will, I hope, have a better and larger Account from the curious and ingenious Dr. *Dowglas*, who is labouring in thoſe Matters.

here the Creator hath ſhewed his Skill, in not over-doing the Matter: in not providing Man with an unneceſſary Apparatus, to effect over and over again what is feaſible, by the Reach of his Underſtanding, and the Power of his Authority.

But for the inferior Creatures, who want Reaſon, the Power of that natural Inſtinct, that Sagacity *(eee)* which the Creator hath imprinted upon them, do amply compenſate that Defect. And here we ſhall find a glorious Scene of the Divine Wiſdom, Power, Providence and Care, if we view the various Inſtincts of Beaſts, great and ſmall, of Birds, Inſects, and Reptiles *(fff)*. For among every Species of them, we may find notable Acts of Sagacity, or Inſtinct, proportional to their Occaſions for Food. Even among thoſe whoſe Food is near at Hand, and eaſily come at; as Graſs and Herbs; and conſequently have no great Need of Art to diſcover it; yet that Faculty of their accurate Smell and Taſte, ſo ready at every Turn, to diſtinguiſh between what is ſalutary, and what pernicious *(ggg)*, doth juſtly deſerve Praiſe. But for ſuch

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(eee) Quibus beſtiis erat is cibus, ut alius generis beſtiis veſcerentur, aut vires natura dedit, aut celeritatem: data eſt quibuſdam etiam machinatio quædam, atque ſolertia, &c. Cic. de Nat. Deor. lib. ii. cap. 48.

(fff) Among Reptiles that have a ſtrange Faculty to ſhift for Food, &c. may be reckoned *Eels*, which, although belonging to the Waters, can creep on the Land from Pond to Pond, &c. Mr. *Moſely* of *Moſely*, ſaw them creep over the Meadows, like ſo many Snakes from Ditch to Ditch; which he thought, was not only for bettering their Habitation, but alſo to catch Snails in the Graſs. *Plot's* Hiſtory of *Staffordſhire*, chap. vii. ſect. 32.

And as early as the Year 1125, the Froſt was ſo very intenſe, that the *Eels* were forced to leave the Waters. and were frozen to Death in the Meadows. *Vide Hakewill's Apol.* lib. ii. cap. 7, ſect. 2.

(ggg) Enumerare poſſum, ad paſtum capeſſendum conficiendumque, quæ ſit in figuris animantium & quàm ſolers, ſubtiliſque deſcriptio

ſuch Animals, whoſe Food is not ſo eaſily come at, a Variety of wonderful Inſtinct may be met with, ſufficient to entertain the moſt curious Obſerver. With what entertaining Power and Artifice do ſome Creatures hunt *(hhh)*, and purſue their Game and Prey! And others watch and way-lay theirs *(iii)*! With what prodigious Sagacity do others grope for

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ſcriptio partium, quamque admirabilis fabrica membrorum. Omnia enim quæ intus incluſa ſunt, ita nata, atque ita locata ſunt, ut nihil eorum ſupervacaneum ſit, nihil ad vitam retinendam non neceſſariam. Dedit autem eadem Natura belluis & ſenſum, & appetitum, ut altero conatum haberent ad naturales paſtus capeſſendos; altero ſecernerent peſtifera à ſalutaribus. Cic. de Nat. Deor. lib. ii. cap. 37. See *Book* IV. *Chap.* 4.

(hhh) It would be endleſs to give Inſtances of my own and others Obſervations, of the prodigious Sagacity of divers Animals in Hunting, particularly Hounds, Setting-Dogs, *&c.* one therefore ſhall ſuffice, of Mr. *Boyle*'s, viz. *A Perſon of Quality—to make a Tryal, whether a young Blood-Hound was well inſtructed,—cauſed one of his Servants—to walk to a Town four Miles off, and then to a Market-Town three Miles from thence.—The Dog, without ſeeing the Man he was to purſue, followed him by the Scent to the above-mentioned Places, notwithſtanding the Multitude of Market-People that went along in the ſame Way, and of Travellers that had Occaſion to croſs it. And when the Blood-Hound came to the chief Market-Town, he paſſed through the Streets, without taking Notice of any of the People there, and left not till he had gone to the Houſe, where the Man he ſought reſted himſelf, and found him in an upper Room, to the Wonder of thoſe that followed him.* Boyl. Determ. Nat. of Effluv. chap. iv.

(iii) There are many Stories told of the Craft of the *Fox*, to compaſs his Prey: Of which *Ol. Magnus* hath many ſuch, as feigning the Barking of a *Dog*, to catch Prey near the Houſes; feigning himſelf dead, to catch ſuch Animals as come to feed upon him; laying his Tail on a Waſp-Neſt, and then rubbing it hard againſt a Tree, and then eating the *Waſps* ſo killed: Ridding himſelf of *Fleas*, by gradually going into the Water, with a Lock of Wool in his Mouth, and ſo driving the *Fleas* up into it, and then leaving it in the Water; By catching *Crab* Fiſh with his Tail, which he ſaith he himſelf was an Eyewitneſs of: *Vidi & ego in Scopulis Norvegiæ Vulpem, inter rupe, immiſſâ caudâ in aquas, plures educere Cancros, ac demum devorare.* Ol. Mag. Hiſt. lib. xviii. cap. 39. 40.

But

for it under Ground, out of Sight, in mooriſh Places, in Mud and Dirt *(kkk)*; and others dig and delve for it, both above *(lll)*, and under the Surface of the drier Lands *(mmm)*! And how curious and well-deſign'd a Proviſion is it of particular large Nerves in ſuch Creatures, adapted to that eſpecial Service!

What an admirable Faculty is that of many Animals, to diſcover their Prey at vaſt Diſtances; ſome by their Smell ſome Miles off *(nnn)*; and ſome by their ſharp and piercing Sight, aloft in

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But *Pliny*'s fabulous Story of the *Hyæna* out-does theſe Relations of the *Fox*, *Sermonem humanam inter paſtorum ſtabula aſſimulare, nomenque alicujus addiſcere, quem evocatum foras laceret. Item Vomitionem hominis imitari ad ſollicitandos Canes quos invadat.* Plin. Nat. Hiſt. lib. viii. cap. 30.

(kkk) This do *Ducks*, *Woodcocks*, and many other Fowls, which ſeek their Food in dirty, mooriſh Places. For which Service they have very remarkable Nerves reaching to the End of their Bills. Of which ſee *Book* VII. *Chap.* ii. *Note (e)*.

(lll) Swine, and other Animals that dig, have their Noſes made more tendinous, callous, and ſtrong for this Service, than others that do not dig. They are alſo edged with a proper, tough Border, for penetrating and lifting up the Earth; and their Noſtrils are placed well, and their Smell is very accurate, to diſcover whatſoever they purſue by Digging.

(mmm) The *Mole*, as its Habitation is different from that of other Animals, ſo hath its Organs in every Reſpect curiouſly adapted to that Way of Life; particularly its Noſe made ſharp, and ſlender, but withal tendinous and ſtrong, *&c.* But what is very remarkable, it hath ſuch Nerves reaching to the End of its Noſe and Lips, as *Ducks*, *&c.* have, mentioned above in *Note (kkk)*. Which Pair of Nerves I obſerved to be much larger in this Animal than any other Nerves proceeding out of its Brain.

(nnn) Predacious Creatures, as *Wolfs*, *Foxes*, *&c.* will diſcover Prey at great Diſtances; ſo will *Dogs* and *Ravens* diſcover Carrion a great Way off by their Smell. And if (as the Superſtitious imagine) the Latter flying over and haunting Houſes be a Sign of Death, it is no Doubt from ſome cadaverous Smell, thoſe *Ravens* diſcover in the Air by their accurate Smell, which is emitted from thoſe diſeaſed Bodies, which have in them the Principles of a ſpeedy Death.

the Air, or at other great Diſtances *(ooo)*! An Inſtance of the Latter of which God himſelf giveth, (*Job* xxxix. 27, 28, 29.) in the Inſtinct of the *Eagle: Doth the Eagle mount up at thy Command, and make her Neſt on High? She dwelleth and abideth on the Rock, upon the Crag of the Rock, and the ſtrong Place (ppp). From thence ſhe ſeeketh her Prey, and her Eyes behold afar off.* What a commodious Proviſion hath the Contriver of Nature made for Animals, that are neceſſitated to climb for their Food; not only in the Structure of their Legs and Feet, and in the Strength of their Tendons and Muſcles, acting in that particular Office *(qqq)*; but alſo in the peculiar Structure of the Principal Parts, Acting in the Acqueſt of their Food *(rrr)*! What a Provi-

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(ooo) Thus *Hawks* and *Kites* on Land, and *Gulls*, and other Birds, that prey upon the Waters, can at a great Height in the Air ſee *Mice*, little Birds and Inſects on the Earth, and ſmall Fiſhes, *Shrimps*, &c. in the Waters, which they will dart down upon, and take.

(ppp) Mr. *Ray* gives a good Account of the Nidification of the *Chryſaëtos, Caudâ annulo albo cinctâ Hujus Nidus. Ann.* 1668. *in ſylvoſis prope Derwentiam &c. inventus eſt è bacillis ſeu virgis ligneis grandioribus compoſitus, quorum altera extremitas rupis cujuſdam eminentiæ, altera duabus Betulis innitebatur, — Erat Nidus quadratus, duas ulnas latus, — In eo pullus unicus, adjacentibus cadaveribus unius agni, unius leporis, & trium Grygallorum pullorum.* Synops. Method. Avium, p. 6. And not only *Lambs, Hares*, and *Grygalli*, but Sir *Robert Sibbald* tells us, they will ſeize *Kids* and *Fawns*; yea, and Children too: Of which he hath this Story of an *Eagle* in one of the *Orcades* Iſlands. *Quæ Infantulum unius anni pannis involutum arripuit (quem Mater teſſellas uſtibiles pro igne allatura momento temporis depoſuerat in loco* Houton-Head *dicto) eumque deportâſſe per 4 milliaria paſſuum ad* Hoiam; *quâ re ex matris ejulatibus cognitâ, quatuor viri illuc in naviculâ profecti ſunt, & ſcientes ubi Nidus eſſet, infantulum illæſum & intactum deprehenderunt.* Prod. Nat. Hiſt. Scot. *lib.* 3. *part.* 2. *p.* 14.

(qqq) See in *Book* VII. *Chap.* 1. *Note (l)*, the Characteriſticks of the *Wood-Pecker kind.*

(rrr) The Contrivance of the Legs, Feet, and Nails [*of the* Opoſſum]

Proviſion alſo is that in nocturnal Birds and Beaſts, in the peculiar Structure of their Eye *(sss)*, (and we may perhaps add the Accuracy of their Smell too) whereby they are enabled to diſcover their Food in the Dark? But among all the Inſtances we have of natural Inſtinct, thoſe Inſtincts, and eſpecial Proviſions made to ſupply the Neceſſities of Helpleſs Animals, do in a particular Manner demonſtrate the great Creator's Care. Of which I ſhall give two Inſtances.

1. The Proviſion made for young Creatures. That Στοργὴ, that natural Affection, ſo connatural to all, or moſt Creatures towards their Young *(ttt)*, what an admirable noble Principle is it, implanted

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Opoſſum] *ſeems very advantageous to this Animal in climbing Trees (which it doth very nimbly) for preying upon Birds.* But that which is moſt ſingular in this Animal, is the Structure of its Tail, to enable it to hang on Boughs. *The Spines, or Hooks — in the middle of the under Side of the* Vertebræ *of the Tail, are a wonderful Piece of Nature's Mechaniſm. The firſt three* Vertebræ *had none of theſe Spines, but in all the reſt they were to be obſerved. — They were placed juſt at the Articulation of each Joint, and in the Middle from the Sides. — For the performing this Office* [of hanging by the Tail] *nothing, I think, could be more advantageouſly contrived. For when the Tail is twirled or wound about a Stick, this Hook of the* Spinæ *eaſily ſuſtains the Weight, and there is but little Labour of the Muſcles required, only enough for bowing or crooking the Tail.* This, and more to the ſame Purpoſe, ſee in Dr. *Tyſon*'s *Anatomy* of the *Opoſſum*, in *Philoſophical Tranſact.* N°. 239.

(sss) See before *Chap.* ii. *Note (z), (aa), (bb).*

(ttt) Quid dicam quantus amor beſtiarum ſit in educandis cuſtodiendiſque iis, quæ procreaverint, uſque ad eum finem, dum poſſint ſeipſa defendere? And having inſtanced in ſome Animals, where this Care is not neceſſary, and accordingly is not employed, he goes on, *Jam Gallinæ, aveſque reliquæ, & quietum requirunt ad pariendum locum, & cubilia ſibi, nidoſque conſtruunt, eoſque quàm poſſunt molliſſimè ſubſternunt, ut quàm facillimè ova ſerventur. Ex quibus pullos cùm excluſerint, ita tuentur, ut & pennis foveant, ne frigore lædantur, & ſi eſt calor, à ſole ſe opponant.* Cic. de Nat. Deor. lib. ii. cap. 51. 52.

ed in them by the wiſe Creator? By Means of which, with what Alacrity do they tranſact their parental Miniſtry? With what Care do they nurſe up their Young; think no Pains too great to be taken for them, no Dangers *(uuu)* too great to be ventured upon for their Guard and Security? How carefully will they lead them about in Places of Safety, carry them into Places of Retreat and Security; yea, ſome of them admit them into their own Bowels *(www)*? How will they careſs

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To this natural Care of Parent-Animals to their Young, we may add the Returns made by the Young of ſome towards the old Ones. *Pliny* ſaith of *Rats, Genitores ſuos ſeſſos ſenectâ, alunt inſigni pietate.* Nat. Hiſt. lib. viii. cap. 57. So *Cranes*, he ſaith, *Genitricum ſenectam invicem educant.* Lib. x. cap. 23.

This St. *Ambroſe* takes Notice of in his *Hexameron*, and *Ol. Magnus* after him, *Depoſiti patris artus, per longævum ſenectutis plumis nudatos circumſtans ſoboles pennis propriis fovet, — collatitio cibo paſcit, quando etiam ipſa naturæ reparat diſpendia, ut hinc inde ſenem ſublevantes, fulcro alarum ſuarum ad volandum exerceant, & in priſtinos uſus deſueta membrana reducant.* For which Reaſon this Bird is denominated *Pia. Vid. Ol. Mag. Hiſt.* lib. xix. cap. 14.

Hereto may be added alſo the conjugal Στοργὴ of the little green *Æthiopian Parrot*, which Mr. *Ray* deſcribes from *Cluſius. Fœmelleæ ſeneſcentes (quod valdè notabile) vix edere volebant, niſi cibum jam à mare carptum, & aliquandiu in prolobo retentum, & quaſi coctum roſtro ſuo exciperent, ut Columbarum pulli à matre ali ſolent.* Synopſ. Meth. Av. p. 32.

(uuu) The moſt timid Animals, that at other Times abſcond, or haſtily fly from the Face of Man, Dogs, &c. will, for the Sake of their Young, expoſe themſelves. Thus among Fowls, *Hens* will aſſault, inſtead of fly from, ſuch as meddle with their Brood. So *Partridges*, before their Young can fly, will drop frequently down, firſt at leſſer, and then at greater Diſtances, to dodge and draw off Dogs from purſuing their Young.

(www) The *Opoſſum* hath a curious Bag on purpoſe for the ſecuring and carrying about her Young. There are belonging to this Bag two Bones (not to be met with in any other Skeleton) and four pair of Muſcles; and ſome ſay the Teats lie therein alſo. Dr. *Tyſon, Anat.* of the *Opoſſ.* in *Philoſoph.*

Tranſ.

reſs them with their affectionate Notes, lull, and quiet them with their tender parental Voice, put Food into their Mouths, ſuckle them, cheriſh and keep them warm, teach them to pick, and eat, and gather Food for themſelves; and, in a Word, perform the whole Part of ſo many Nurſes, deputed by the Sovereign Lord and Preſerver of the World, to help ſuch young and ſhiftleſs Creatures, till they are come to that Maturity, as to be able to ſhift for themſelves?

And as for other Animals, (particularly Inſects, whoſe Sire is partly the Sun, and whoſe numerous Offspring would be too great for their Parent-Animals Care and Proviſion) theſe are ſo generated, as to need none of their Care, by Reaſon they arrive immediately to their Ἡλικία, their perfect, adult State, and are able to ſhift for themſelves. But yet, thus far their parental Inſtinct (equivalent to the moſt rational Care and Foreſight) doth extend, that the old ones do not wildly drop their Eggs and Sperm any where, at all Adventures, but ſo cautiouſly repoſit it in ſuch commodious Places, (ſome in the Waters, ſome on Fleſh, ſome on Plants) proper and agreeable to their Species *(xxx)*; and ſome ſhut up agreeable Food in their Neſts, partly for Incubation, partly for Food *(yyy)*, that their Young in their *Aurelia*, or *Nympha* State, may find ſufficient and agreeable Food to bring them up, till they arrive to their Maturity.

Thus far the Parental Inſtinct and Care.

Tranſ. N° 239. where he alſo, from *Oppian*, mentions the *Dog Fiſh*, that upon any Storm or Danger, receives the young ones into her Belly, which come out again when the Fright is over. So alſo the *Squatina* and *Glaucus*, the ſame Author ſaith, have the ſame Care for their Young, but receive them into different Receptacles.

(xxx) See *Book* VIII. *Chap.* vi.

(yyy) See *Chap.* xiii. *Note (c)*.

Next we may obſerve no leſs in the Young themſelves, eſpecially in thoſe of the irrational Animals. Foraſmuch as the Parent-Animal is not able to bear them about, to cloath them, and to dandle them, as Man doth; how admirably hath the Creator contrived their State, that thoſe poor young Creatures can ſoon walk about, and with the little Helps of their Dam, ſhift for, and help themſelves? How naturally do they hunt for their Teat, ſuck, pick *(zzz)*, and take in their proper Food?

But for the Young of Man, their Parents Reaſon joined with natural Affection, being ſufficient to help to nurſe, to feed, and to clothe them; therefore they are born helpleſs, and are more abſolutely, than other Creatures, caſt upon their Parents Care *(aaaa)*. A manifeſt Act and Deſignation of the Divine Providence.

2. The other Inſtance I promiſed, is the Proviſion made for the Preſervation of ſuch Animals as are ſometimes deſtitute of Food, or in danger of being ſo. The Winter is a very inconvenient, improper Seaſon, to afford either Food or Exerciſe to Inſects, and many other Animals. When the

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(zzz) There is manifeſtly a ſuperintending Providence in this Caſe, that ſome Animals are able to ſuck as ſoon as ever they are born, and that they will naturally hunt for the Teat before they are quite gotten out of the Secundines, and parted from the Navel-String, as I have ſeen. But for *Chickens*, and other young Birds, they not being able immediately to pick till they are ſtronger, have a notable Proviſion made for ſuch a Time, by a Part of the Yolk of the Egg being incloſed in their Belly, a little before their Excluſion or Hatching, which ſerves for their Nouriſhment, till they are grown ſtrong enough to pick up Meat. *Vide Book* VII. *Chap.* iv. *Note (a).*

(aaaa) Qui [Infantes] *de ope noſtrâ ac de divinâ miſericordiâ plus merentur, qui in primo ſtatim nativitatis ſuæ ortu plorantes ac flentes, nil aliud faciunt quàm deprecantur.* Cypr. Ep. ad Fid.

flowery Fields are diveſted of their Gaiety; when the fertile Trees and Plants are ſtripped of their Fruits, and the Air, inſtead of being warmed with the cheriſhing Beams of the Sun, is chilled with rigid Froſt; What would become of ſuch Animals as are impatient of Cold? What Food could be found by ſuch as are ſubſiſted by the Summer-Fruits? But to obviate all this Evil, to ſtave off the Deſtruction and Extirpation of divers Species of Animals, the infinitely wiſe Preſerver of the World hath as wiſely ordered the Matter; that, in the firſt Place, ſuch as are impatient of Cold, ſhould have ſuch a ſpecial Structure of their Body, particularly of their Hearts, and Circulation of their Blood *(bbbb)*, as during that Seaſon, not to ſuffer any Waſte of their Body, and conſequently not to need any Recruits; but, that they ſhould be able to live in a kind of ſleepy, middle Sate, in their Places of ſafe Retreat, until the warm Sun revives both them and their Food together.

The next Proviſion is for ſuch as can bear the Cold, but would want Food then; and that is in ſome by a long Patience of Hunger *(cccc)*, in others by

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(bbbb) I might name here ſome of the Species of Birds, the whole Tribe almoſt of Inſects, and ſome among other Tribes, that are able to ſubſiſt for many Months without Food, and ſome without Reſpiration too, or very little: But it may ſuffice to inſtance only in the *Land Tortoiſe*, of the Structure of whoſe Heart and Lungs, ſee *Book* VI. *Chap.* v. *Note (b)*.

(cccc) Inediam diutiſſimè tolerat Lupus, ut & alia omnia carnivora, licèt voraciſſima; magnâ utique naturæ providentia; quoniam eſca non ſemper in promptu eſt. Ray's Synopſ. Quadr. p. 174.

To the long Abſtinence mentioned of Brute Animals, I hope the Reader will excuſe me, if I add one or two Inſtances of extraordinary Abſtinence among Men. One *Martha Taylor*, born in *Derbyſhire*, by a Blow on the Back fell into ſuch a Proſtration of Appetite, that ſhe took little Suſtenance, but by their notable Inſtinct in laying up Food beforehand againſt the approaching Winter *(dddd)*. Of this many entertaining Examples may be given; particularly we may, at the proper Seaſon, obſerve not only the little Treaſures and Holes well-ſtocked with timely Proviſions, but large Fields *(eeee)* here and there throughout beſpread with conſiderable Num-

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but ſome Drops with a Feather, from *Chriſtmas*, 1667, for thirteen Months, and ſlept but little too all the Time. See Dr. *Sampſon*'s Account thereof, in *Ephem. Germ. T.* iii. *Obſ.* 173.

To this we may add the Caſe of *S. Chilton*, of *Tinſbury*, near *Bath*, who, in the Years 1693, 1696, and 97, ſlept divers Weeks together. And although he would ſometimes, in a very odd manner, take Suſtenance, yet would lie a long Time without any, or with very little, and all without any conſiderable Decay. See *Phil. Tranſ.* N° 304.

(dddd) They are admirable Inſtincts which the Sieur *de Beauplau* relates of his own Knowledge, of the little Animals called *Bobaques* in *Ukraine. They make Burroughs like* Rabbets, *and in* October *ſhut themſelves up, and do not come out again till* April.—*They ſpend all the Winter under Ground, eating what they laid up in Summer.*—*Thoſe that are lazy among them, they lay on their Back, then lay a great Handful of dry Herbage upon their Bodies, &c. then others drag thoſe Drones to the Mouths of their Burroughs, and ſo thoſe Creatures ſerve inſtead of Barrows,* &c. *I have often ſeen them practiſe this, and have had the Curioſity to obſerve them whole Days together.*—*Their Holes are parted like Chambers; ſome ſerve for Store-houſes, others for Burying-places,* &c. *Their Government is nothing inferior to that of* Bees, &c. *They never go abroad without poſting a Centinel upon ſome high Ground, to give Notice to the others whilſt they are feeding. As ſoon as the Centinel ſees any Body, it ſtands upon its Hind-legs and whiſtles.* Beauplau'*s Deſcription of* Ukraine, *in* Vol. I. *of the* Collection of Voyages, *&c.*

A like Inſtance of the Northern *Galli Sylveſtres*, ſee in *Chap.* xiii. *Note (g).*

As for the Scriptural Inſtance of the *Ant*, ſee hereafter *Book* VIII. *Chap.* v. *Note (d).*

(eeee) I have in *Autumn*, not without Pleaſure, obſerved, not only the great Sagacity and Diligence of *Swine*, in hunting out the Stores of the *Field Mice*; but the wonderful Precaution alſo of thoſe little Animals, in hiding their Food beforehand againſt Winter. In the Time of Acorns falling, I have,

Numbers of the Fruits of the neighbouring Trees, laid carefully up in the Earth, and covered ſafe, by the provident little Animals inhabiting thereabouts. And not without Pleaſure, have I ſeen and admired the Sagacity of other Animals, hunting out thoſe ſubterraneous Fruits, and pillaging the Treaſures of thoſe little provident Creatures.

And now, from this bare tranſient View of this Branch of the Great Creator's Providence and Government, relating to the *Food* of his Creatures, we can conclude no leſs, than that ſince this Grand Affair hath ſuch manifeſt Strokes of admirable and wiſe Management, that ſince this is demonſtrated throughout all Ages and Places, that therefore it is God's Handy-Work. For how is it poſſible that ſo vaſt a World of Animals ſhould be ſupported, ſuch a great Variety equally and well ſupplied with proper Food, in every Place fit for Habitation, without an eſpecial Superintendency and Management, equal to, at leaſt, that of the moſt prudent Steward and Houſholder? How ſhould the Creatures be able to find out their Food when laid up in ſecret Places? And how ſhould they be able to gather even a great deal of the common Food, and at laſt to macerate and digeſt it, without peculiar Organs adapted to the Service? And what leſs than an infinitely Wiſe God could form ſuch a Set of curious Organs, as we find every Species endowed with, for this very Uſe? Organs ſo artificially made, ſo exquiſitely fitted up, that the more ſtrictly we ſurvey them, the more accurately we view them, (even in the meaneſt of them with our beſt Glaſſes)

I have, by means of the *Hogs*, diſcovered, that the *Mice* had, all over the neighbouring Fields, treaſured up ſingle Acorns in little Holes they had ſcratched, and in which they had carefully covered up the Acorn. Theſe the *Hogs* would, Day after Day, hunt out by their Smell.

the leſs Fault we find in them, and the more we admire them: Whereas the beſt poliſhed, and moſt exquiſite Works, made by human Art, appear thro' our Glaſſes, as rude and bungling, deformed and monſtrous; and yet we admire them, and call them Works of Art and Reaſon. And laſtly, What leſs than Rational and Wiſe, could endow irrational Animals with various Inſtincts, equivalent, in their ſpecial Way, to Reaſon itſelf? Inſomuch that ſome from thence have abſolutely concluded, that thoſe Creatures had ſome Glimmerings of Reaſon. But it is manifeſtly Inſtinct, not Reaſon, they act by, becauſe we find no varying, but that every Species doth naturally purſue at all Times the ſame Methods and Way, without any Tutorage or Learning: Whereas *Reaſon*, without Inſtruction, would often vary, and do that by many Methods, which *Inſtinct* doth by one alone. But of this more hereafter.

CHAP. XII.

Of the Cloathing of Animals.

HAVING in the foregoing Chapter, ſomewhat largely taken a View of the infinite Creator's Wiſdom and Goodneſs towards his Creatures, in ordering their Food, I ſhall be more brief in this Chapter, in my View of their *Cloathing* (a); ano-

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(a) Concerning the *Cloathing* of Animals, *Ariſtotle* obſerves, *That ſuch Animals have Hair as go on Feet, and are viviparous; and that ſuch are covered with a Shell, as go on Feet, and are oviparous.* Hiſt. Anim. lib. iii. chap. 19.

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ther neceſſary Appendage of Life, and in which we have plain Tokens of the Creator's Art, manifeſted in theſe two Particulars; the *Suitableneſs of Animals Cloathing to their Place and Occaſions*; and the *Garniture and Beauty thereof.*

I. The Cloathing of Animals is ſuited to their Place of Abode, and Occaſions there; a manifeſt Act of Deſign and Skill. For if there was a Poſſibility, that Animals could have been accoutred any other Way, than by God that made them, it muſt needs have come to paſs, that their Cloathing would have been at all Adventures, or all made the ſame Mode and Way, or ſome of it, at leaſt, inconvenient and unſuitable. But, on the contrary, we find all is curious and complete, nothing too much, nothing too little, nothing bungling, nothing but what will bear the Scrutiny of the moſt exquiſite Artiſt; yea, and ſo far out-do his beſt Skill, that his moſt exquiſite Imitations, even of the meaneſt Hair, Feather, Scale, or Shell, will be found only ſo many ugly, ill-made Blunders and Botches, when ſtrictly brought to the Teſt of good Glaſſes. But we ſhall find an Example remarkable enough in the preſent Caſe, if we only compare the beſt of Cloathing which Man makes for himſelf, with that given by the Creator for the Covering of the irrational Creatures. Of which it may be ſaid, as our *Saviour* doth of the Flowers of the Field, *Matt.* vi. 29. *That even Solomon, in all his Glory, was not arrayed like one of theſe.*

But let us come to Particulars, and conſider the Suitableneſs of the different Method the Creator hath taken in the Cloathing of Man, and of the irrational Animals. This *Pliny* (b) pathetically laments;

(b) *Cujus* [Hominis] *causâ videtur cuncta alia genuiſſe Natura, magnâ & ſævâ mercede contra tanta ſua munera: ut non* ments, and ſays, *It is hard to judge, whether Nature hath been a kinder Parent, or more cruel Step-Mother to Man.* For, ſays he, *Of all Creatures, he alone is covered with others Riches; whereas Nature hath given various Cloathing to other Animals, Shells, Hides, Prickles, Shag, Briſtles, Hair, Down, Quills, Scales, Fleeces; and Trees ſhe hath fenced with a Bark or two againſt the Injuries of Cold and Heat. Only poor naked Man,* ſays he, *is in the Day of his Birth caſt into the wide World, to immediate Crying and Squalling; and none of all Creatures beſides, ſo ſoon to Tears in the very Beginning of their Life.*

But here we have a manifeſt Demonſtration of the Care and Wiſdom of God towards his Creatures; that ſuch ſhould come into the World with their Bodies ready furniſhed and accommodated, who had neither Reaſon nor Forecaſt to contrive, nor Parts adapted to the Artifices and Workmanſhip of Cloathing; but for Man; he being endowed with the tranſcending Faculty of Reaſon, and thereby made able to help himſelf, by having

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ſit ſatis æſtimare. Parens melior homini, an triſtior Noverca fuerit. Ante omnia unum Animantium cunctorum alienis velat opibus: cæteris variè tegumenta tribuit, teſtas, cortices, coria, ſpinas, villos, ſetas, pilos, plumam, pennas, ſquamas, vellera. Truncos etiam arboreſque cortice, interdum gemino, à frigoribus, & calore tutata eſt. Hominem tantum nudum, & in nudâ humo, natali die abjicit ad vagitus ſtatim & ploratum, nullumque tot animalium aliud ad lacrymas, & has protinus vitæ principio. Plin. Nat. Hiſt. lib. vii. Proœm.

Let *Seneca* anſwer this Complaint of *Pliny*, although perhaps what he ſaith might be more properly noted in another Place: *Quiſquis es iniquus æſtimator ſortis humanæ, cogita quanta nobis tribuerit Parens noſter, quanta valentiora animalia ſub jugum miſerrimus, quanto velociora aſſequamur, quam nihil ſit mortale non ſub ictu noſtro poſitum. Tot virtutes accepimus, tot artes, animum denique cui nihil non eodem quo intendit momento pervium eſt, Sideribus velociorem, &c.* Senec. de Benef. lib. ii. cap. 29.

Thoughts to contrive, and withal Hands to effect; and ſufficient Materials (c) afforded him from the Skins and Fleeces of Animals, and from various Trees and Plants: Man, I ſay, having all this Proviſion made for him, therefore the Creator hath

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(c) *Mirantur plurimi quomodo tutè, & ſanè vivant homines in horrendis frigoribus plagæ Septentrionalis: hancque levem quæſtionem ultra 30 annos audieram in Italiâ, præſertim ab Æthiopibus, & Indis, quibus oneroſus videtur veſtitus ſub Zonâ torridâ.— Quibus reſpondetur, — Gaudet Indus multiplici plumarum genere, magis forſan pro tegumento, quàm neceſſitate: rurſus Scytha villoſo veſtitu. — Ita ſub polo Arctico adverſus aſperrimas hyemes — opportuna remedia faciliter adminiſtrat* [Natura,] *Ligna videlicet in maximâ copiâ, & leviſſimo pretio, & demum Pelles diverſorum animalium, tam ſylveſtrium quam domeſticorum.* Then he gives a Catalogue of them, and ſaith, *Quarum omnium experti pelliſices ita ingenioſè noverunt mixturas componere, ut pulcherrimum decorem oſtendat varietas, & calidiſſimum fomentum adjuncta mollities.* Ol. Mag. Hiſt. lib. vi. cap. 20.

To this Guard againſt the Cold, namely, of Fire and Cloathing, I hope the Reader will excuſe me, if I take this Opportunity of adding ſome other Defenſatives, Nature (or rather the great Author of Nature) hath afforded theſe Northern Regions: Such are their high Mountains, abounding, as *Ol. Magnus* ſaith, through all Parts; alſo, their numerous Woods, which, beſides their Fire, do, with the Mountains, ſerve as excellent Screens againſt the Cold, piercing Air, and Winds. Their prodigious Quantities of Minerals, and Metals, alſo afford Heat, and warm Vapours, *Mineræ ſeptentrionalium regionum ſatis multæ, magnæ, diverſæ, & opulentæ ſunt,* ſaith the ſame curious, and (for his Time) learned Archbiſhop, lib. vi. cap. 1. and in other Places. And for the Warmth they afford, the *Volcanos* of thoſe Parts are an Evidence; as are alſo their terrible Thunder and Lightning, which are obſerved to be the moſt ſevere and miſchievous in their metalline Mountains, in which large Herds of Cattle are ſometimes deſtroyed; the Rocks ſo rent and ſhattered, that new Veins of Silver are thereby diſcovered; and a troubleſome kind of Quinſie is produced in their Throats, by the Stench, and poiſonous Nature of the ſulphureous Vapours, which they diſſolve, by drinking warm Beer and Butter together, as *Olaus* tells us in the ſame Book, *Chap.* xi.

To all which Defenſatives, I ſhall in the laſt Place add, the warm Vapours of their Lakes, (ſome of which are prodigiouſly large, hath wiſely made him naked, and left him to ſhift for himſelf, being ſo well able to help himſelf.

And a notable Act this is of the Wiſdom of God, not only as the mere ſetting forth his Care and Kindneſs to them that moſt needed his Help, the helpleſs irrational Animals, and in his not over-doing his Work; but alſo as it is moſt agreeable to the Nature and State of Man (*d*), both on natural and political Accounts. That Man ſhould cloath himſelf, is moſt agreeable to his Nature, particularly

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large, of 130 *Italian* Miles in Length, and not much leſs in Breadth;) alſo of their Rivers, eſpecially the Vapours which ariſe from the Sea. Of which Guard againſt ſevere Cold, we have lately had a convincing Proof in the *Great Froſt*, in 1708, wherein, when *England*, *Germany*, *France*, *Denmark*, yea, the more Southerly Regions of *Italy*, *Switzerland*, and other Parts, ſuffered ſeverely, *Ireland* and *Scotland* felt very little of it; hardly more than in other Winters; of the Particulars of which, having given an Account in the *Philoſ. Tranſ.* N° 324. I ſhall thither refer the Reader. But it ſeems, this is what doth ordinarily befal thoſe Northern Parts; particularly the *Iſlands* of *Orkney*, of which the learned Dr. *Wallace* gives this Account: *Here the Winters are generally more ſubject to Rain than Snow; nor doth the Froſt and Snow continue ſo long here as in other Parts of* Scotland; *but the Wind in the mean time will often blow very boiſterouſly; and it rains ſometimes not by Drops but by Spouts of Water, as if whole Clouds fell down at once. In the Year* 1680, *in the Month of* June, *after great Thunder, there fell Flakes of Ice near a Foot thick.* Wall. Account of Orkney, Chap. i. p. 4. From which laſt Paſſage I obſerve, That although in thoſe Parts, the Atmoſphere near the Earth be warm, it is exceſſively cold above ſo as to freeze ſome of thoſe Spouts of Water in their Deſcent, into ſuch great and almoſt incredible, Maſſes of Hail. And whence can this Warmth proceed, but from the Earth, or Sea, emitting Heat ſufficient to ſtave off the Cold above? Conſult *Book* II. *Chap.* v. *Note* (*c*).

(*d*) *Sicut enim ſi innata ſibi* [i. e. Homini] *aliqua haberet arma, illa ei ſola ſemper adeſſent, ita & ſi artem aliquam Natura ſortitus eſſet, reliquas ſanè non haberet. Quia verò ei melius erat omnibus armis, omnibuſque artibus uti, neutrum eorum à naturâ ipſi propterea datum eſt.* Galen de Uſ. Part. lib. i. cap. 4.

(among other Things,) as being moſt ſalutary, and moſt ſuitable to his Affairs. For by this Means, Man can adapt his Cloathing to all Seaſons, to all Climates, to this, or to any Buſineſs. He can hereby keep himſelf ſweet and clean, fence off many Injuries; but above all, by this Method of Cloathing, with the natural Texture of his Skin adapted to it, it is that grand Means of Health, namely, *inſenſible Perſpiration* (e), is performed, at leaſt greatly promoted, without which an human Body would be ſoon over-run with Diſeaſe.

In the next Place, there are good political Reaſons for Man's Cloathing himſelf, inaſmuch as his Induſtry is hereby employed in the Exerciſes of his Art and Ingenuity; his Diligence and Care are exerted in keeping himſelf ſweet, cleanly, and neat; many Callings and Ways of Life ariſe from thence, and (to name no more,) the Ranks and Degrees of Men are hereby, in ſome Meaſure, rendered viſible to others, in the ſeveral Nations of the Earth.

Thus it is manifeſtly beſt for Man, that he ſhould cloath himſelf.

(e) Concerning *Inſenſible Perſpiration*, *Sanctorius* obſerves, that it much exceeds all the Senſible put together. *De Stat. Med. Aph.* 4. That as much is evacuated by *Inſenſible Perſpiration* in one Day, as is by *Stool* in fourteen Days: Particularly, That, in a Night's Time, about ſixteen Ounces is commonly ſent out by *Urine*, four Ounces by *Stool*; but above forty Ounces by *inſenſible Perſpiration.* Aphor. 59, 60. That if a Man eats and drinks eight Pounds in a Day, five Pounds of it is ſpent in *inſenſible Perſpiration.* Sect. 1. Aph. 6. And as to the Times, he ſaith, *Ab aſſumpto cibo 5 horis 1 l. circiter; perſpirabilis — exhalare ſolet, à 5a ad 12am 3 l. circiter; à 12a ad 16am vix ſelibram.* Aph. 56.

And as to the wonderful Benefits of *inſenſible Perſpiration*, they are abundantly demonſtrated by the ſame learned Perſon, *ubi ſupra*; as alſo by *Borelli* in his ſecond Part, *De Mot. Animal.* Prop. 168. who ſaith, *Neceſſaria eſt inſenſibilis Tranſpiratio, ut vita Animalis conſervetur.*

But for the poor ſhiftleſs Irrationals, it is a prodigious Act of the great Creator's Indulgence, that they are all ready furniſhed with ſuch Cloathing, as is proper to their Place and Buſineſs (*f*). Some covered with Hair (*g*), ſome with Feathers,

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(*f*) *Animantium verò quanta varietas eſt? Quanta ad eam rem vis, ut in ſuo quæque genere permaneant? Quarum aliæ coriis tectæ ſunt, aliæ villis veſtitæ, aliæ ſpinis hirſutæ: plumâ alias, alias ſquamâ videmus obductas, alias eſſe cornibus armatas, alias habere effugia pennarum.* Cic. de Nat. Deor. lib. ii. cap. 47.

(*g*) From *Malpighi*'s curious Obſervations of the *Hair*, I ſhall note three Things: 1. Their Structure is fiſtulous, or tubular; which hath long been a Doubt among the Curious. *Fiſtuloſum* [eſſe Pilum] *demonſtrant luſtratio pilarum à caudâ & collo Equorum, &c. — præcipuè ſetarum Apri, quæ patentiorem ex fiſtulis compoſitionem exhibent. Eſt autem dictus Apri pilus Cylindricum corpus quaſi diaphanum — fiſtularum aggere conflatum, & ſpeciem columnæ ſtriatæ præ ſe fert. Componentes fiſtulæ in gyrum ſituatæ in apice patentiores redduntur; nam hians pilus in geminas dividitur partes, & componentes minimæ fiſtulæ — liberiores redditæ manifeſtantur, ita ut enumerari poſſunt; has autem 20, & ultra numeravi. — Expoſitæ fiſtulæ — tubuloſæ ſunt, & frequentibus tunicis tranſverſaliter ſituatis, veluti valvulis pollent. Ex quoniam Spinæ, in Erinaceis præcipui, &c. nil aliud ſunt, quam duri & rigidi pili, ideo, &c.* And then he deſcribes the *Hedgehog*'s Spines, in which thoſe Tubes manifeſtly appear; together with medullary Valves and Cells; not inelegant, which he hath figured in *Tab.* 16. at the End of his Works.

That which this ſagacious, and not enough to be commended Obſerver took notice of in the Structure of Hair, and its Parity to the Spines, I have obſerved myſelf in ſome meaſure to be true, in the Hair of *Cats*, *Rats*, *Mice*, and divers other Animals; which look very prettily when viewed with a good Microſcope. The Hair of a *Mouſe*, (the moſt tranſparent of any I have viewed,) ſeems to be one ſingle tranſparent Tube, with a Pith made up of a fibrous Subſtance, running in dark Lines; in ſome Hairs tranſverſly, in others ſpirally, as in *Fig.* 14, 15, 16, 17. Theſe darker medullary Parts, or Lines, I have obſerved, are no other than ſmall Fibres convolved round, and lying cloſer together than in other Parts of the Hair. They run from the Bottom to the Top of the Hair; and, I imagine, ſerve to the gentle Evacuation of ſome Humour out of the Body; perhaps, the Hair ſerves as thers *(h)*, ſome with Scales, ſome with Shells *(i)*, ſome only Skin, and ſome with firm and ſtout Armature; all nicely accommodated to the Element in which the Creature liveth, and its Occaſions there *(k)*. To *Quadrupeds* Hair is a commodious Cloathing; which, together with the apt Texture of their Skin, fitteth them for all Weathers, to lie on the Ground, and to do the Offices of Man; and the thick and warm Furs and Fleeces of others, are not only a good Defenſative againſt the Cold and Wet; but alſo a ſoft Bed to repoſe themſelves in; and to many of them, a comfortable Covering, to nurſe and cheriſh their tender Young.

And as Hair to Quadrupeds, ſo Feathers are as commodious a Dreſs to ſuch as fly in the Air, to Birds, and ſome Inſects; not only a good Guard againſt Wet and Cold, and a comfortable Covering to ſuch as hatch and brood their Young; but

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as well for the *inſenſible Perſpiration* of hairy Animals, as to fence againſt Cold and Wet. In *Fig.* 14, 16. is repreſented the Hair of a *Mouſe*, as it appears through a ſmall Magnifier; and in *Fig.* 15, 17. as it appears when viewed with a larger Magnifier.

Upon another Review, I imagine, that although in *Fig.* 14, 15. the dark Parts of the Pith ſeem to be tranſverſe, that they, as well as in the two other Figures, run round in a ſcrew-like Faſhion.

(h) See *Book* VII. *Chap.* i. *Note (d), (e).*

(i) See *Chap.* xiv. *Note (c).*

(k) It is a Sign ſome wiſe Artiſt was a Contriver of the Cloathing of Animals, not only as their Cloathing varies, as their Way of Living doth; but alſo becauſe every Part of their Bodies is furniſhed with proper ſuitable Cloathing. Thus divers Animals, that have their Bodies covered for the moſt Part with ſhort, ſmooth Hair, have ſome Parts left naked, where Hair would be an Annoyance; and ſome Parts beſet with long Hair, as the Mane and Tail; and ſome with ſtiff, ſtrong Briſtles, as about the Noſe; and ſometimes within the Noſtrils, to guard off, or give warning of Annoyances.

alſo moſt commodious for their Flight. To which Purpoſe they are nicely and neatly placed every where on the Body, to give them an eaſy Paſſage through the Air *(l)*, and to aſſiſt in the wafting their Body thro' that thin Medium. For which Service, how curious is their Texture for Lightneſs, and withal for Strength? Hollow and thin for Lightneſs, but withal context and firm for Strength. And where it is neceſſary they ſhould be filled, what a light and ſtrong, medullary Subſtance is it they are filled with? By which curious Contrivances, even the very heavieſt Parts made for Strength, are ſo far from being a Load to the Body, that they rather aſſiſt in making it light and buoyant, and capacitate it for Flight. But for the Vanes, the lighteſt Part of the Feather, how curiouſly are they wrought with capillary Filaments, neatly interwoven together *(m)*, whereby they are not only light, but alſo ſufficiently cloſe and ſtrong, to keep the Body warm, and guard it againſt the Injuries of Weather, and withal, to empower the Wings, like ſo many Sails, to make ſtrong Impulſes upon the Air in their Flight *(n)*. Thus curious, thus artificial, thus commodious, is the Cloathing of Beaſts

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(l) The Feathers being placed from the Head towards the Tail, in cloſe and neat Order, and withal preened and dreſſed by the Contents of the Oil-Bag, afford as eaſy a Paſſage through the Air, as a Boat new cleaned and dreſſed finds in its Paſſage through the Waters. Whereas, were the Feathers placed the contrary, or any other Way, (as they would have been, had they been placed by Chance, or without Art) they would then have gathered Air, and been a great Encumbrance to the Paſſage of the Body through the Air. See *Book* VII. *Chap.* i. *Note (b)*.

(m) In *Book* VII. *Chap.* 1. *Note (e)*, there is a particular Account of the Mechaniſm of their Vanes, from ſome nice Microſcopical Obſervations, and therefore I ſhall take no farther Notice of it here.

(n) Vide Borell. de Mot. Animal. Prop. 182. Vol. I.

and Birds: Concerning which, more in proper Place.

And no leſs might I ſhew that of Reptiles and Fiſhes *(o)* to be, if it was convenient to enlarge upon this Branch of the Creator's Works. How well adapted are the *Annuli* of ſome Reptiles, and the Contortions of the Skin of others, not only to fence the Body ſufficiently againſt outward Injuries, but to enable them to creep, to perforate the Earth *(p)*; and, in a Word, to perform all the Offices of their Reptile State, much better than any other Tegument of the Body would do? And the ſame might be ſaid of the Covering of the Inhabitants of the Waters, particularly the Shells of ſome, which are a ſtrong Guard to the tender Body that is within, and conſiſtent enough with their ſlower Motion; and the Scales and Skins of others, affording them an eaſy and ſwift Paſſage thro' the Waters. But it may be ſufficient to give only a Hint of thoſe Things,

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(o) See *Book* IX.

(p) For a Sample of this Branch of my Survey, let us chuſe the Tegument of *Earth-Worms*, which we ſhall find completely adapted to their Way of Life and Motion, being made in the moſt complete Manner poſſible for terebrating the Earth, and creeping where their Occaſions lead them: For their Body is made throughout of ſmall Rings, and theſe Rings have a curious *Apparatus* of Muſcles, enabling thoſe Creatures with great Strength to dilate, extend, or contract their *Annuli*, and whole Body; thoſe *Annuli* alſo are each of them armed with ſmall, ſtiff, ſharp *Beards*, or *Prickles*, which they can open, to lay hold on, or ſhut up cloſe to their Body: And laſtly, under the Skin there lies a *ſlimy Juice*, that they emit, as Occaſion is, at certain Perforations between the *Annuli*, to lubricate the Body, and facilitate their Paſſage into the Earth. By all which Means they are enabled, with great Speed, Eaſe, and Safety, to thruſt and wedge themſelves into the Earth; which they could not do, had their Bodies been covered with Hair, Feathers, Scales, or ſuch like Cloathing of the other Creatures. See more concerning this Animal, *Book* IX. *Chap.* i. *Note (a).*

Things, which more properly belong to another Place.

Thus hath the indulgent Creator furniſhed the whole Animal World with convenient, ſuitable Cloathing.

II. Let us, in the next Place, take a ſhort View of the *Garniture* (q), and *Beauty* thereof. And here we ſhall thus far, at leaſt, deſcry it to be beautiful, that it is complete and Workman-like. Even the Cloathing of the moſt ſordid Animals, thoſe that are the leaſt beautified with Colours, or rather whoſe Cloathing may regrate the Eye (r); yet when we come ſtrictly to view them, and ſeriouſly conſider the nice Mechaniſm of one Part, the admirable Texture of another, and the exact Symmetry of the Whole; we diſcern ſuch Strokes of inimitable Skill, ſuch incomparable Curioſity, that we may ſay with *Solomon*, Eccl. iii. 11, [GOD] *hath made every Thing beautiful in his Time.*

But for a farther Demonſtration of the ſupereminent Dexterity of his Almighty Hand, he hath been pleaſed, as it were on Purpoſe, to give ſurprizing Beauties to divers Kinds of Animals. What radiant Colours are many of them, particularly ſome Birds and Inſects (s), bedecked with! What a prodigious Combination is there often of theſe, yea, how nice an Air frequently of meaner Colours *(t)*, as to captivate the Eye of all Beholders, and exceed the Dexterity of the moſt exquiſite Pencil to copy?

(q) *Ariſtotle*, in his *Hiſt. Anim.* lib. iii. cap. 12, names ſeveral Rivers, that by being drank of, change the Colour of the Hair.

(r) For an Example, Let us take the Cloathing of the *Tortoiſe* and *Viper*; becauſe, by an incurious View, it rather regrateth than pleaſeth the Eye: But yet, by an accurate Survey, we find the Shells of the Former, and the Scales of the Latter, to be a curious Piece of Mechaniſm, neatly made, and ſo completely, and well put and tacked together as to exceed any human Compoſures: Of the Latter, ſee more in *Book* IX. *Chap.* i. *Note* (c).

(s) It would be endleſs to enter into the Particulars of the beautiful *Birds* and *Inſects* of our *European* Parts; but eſpecially thoſe inhabiting the Countries between the Tropicks, which

And now, when we thus find a whole World of Animals, cloathed in the wiſeſt Manner, the moſt ſuitable to the Element in which they live, the Place in which they reſide, and their State and Occaſions there; when thoſe that are able to ſhift for themſelves, are left to their own Diſcretion and Diligence, but the Helpleſs well accoutered and provided for; when ſuch imcomparable Strokes of Art and Workmanſhip appear in all, and ſuch inimitable Glories and Beauties in the Cloathing of others; who can, without the greateſt Obſtinacy and Prejudice, deny this to be GOD's Handy-work? The gaudy, or even the meaneſt Apparel, which Man provideth for himſelf, we readily enough own to be the Contrivance, the Work of Man: And ſhall we deny the Cloathing of all the Animal World beſides (which infinitely ſurpaſſeth all the Robes of earthly Majeſty; ſhall we, dare we, deny that) to be the Work of any Thing leſs than of an infinite, intelligent Being, whoſe Art and Power are equal to ſuch glorious Work!

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which are obſerved as much to exceed our Birds in their Colours, as ours do theirs in their Singing.

(t) The *Wryneck*, at a diſtance, is a Bird of mean Colour; neither are indeed its Colours radiant, or beautiful, ſingly conſidered: But when it is in the Hand, we ſee its light and darker Colours ſo curiouſly mixed together, as to give the Bird a ſurprizing Beauty. The ſame is alſo obſervable in many Inſects, particularly of the *Phalæna* Kind.

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CHAP. XIII.

Of the Houſes and Habitation of Animals.

HAVING in the laſt Chapter, as briefly as well I could, ſurveyed the *Cloathing* of Animals, I ſhall in this take a View of their *Houſes*, *Neſts*, their *Cells* and *Habitations*, another Thing no leſs neceſſary to their Well-being than the laſt; and in which the Great Creator hath likewiſe ſignallized his Care and Skill, by giving Animals an Architectonick Faculty, to build themſelves convenient Places of Retirement, in which to repoſe and ſecure themſelves, and to nurſe up their Young.

And here, as before, we may conſider the Caſe of Man, and that of the irrational Animals. Man having (as I ſaid) the Gift of Reaſon and Underſtanding, is able to ſhift for himſelf, to contrive and build, as his Pleaſure leads him, and his Abilities will admit of. From the meaneſt Huts and Cottages, he can erect himſelf ſtately Buildings, bedeck them with exquiſite Arts of Architecture, Painting, and other Garniture; ennoble them, and render them delightful with pleaſant Gardens, Fountains, Avenues, and what not? For Man therefore the Creator hath abundantly provided in this Reſpect, by giving him an Ability to help himſelf. And a wiſe Proviſion this is, inaſmuch as it is an excellent Exerciſe of the Wit, the Ingenuity, the Induſtry, and Care of Man.

But ſince Ingenuity, without Materials, would be fruitleſs, the Materials therefore which the Creator hath provided the World with, for this very Service of Building, deſerves our Notice. The great Varieties of Trees *(a)*, Earth, Stones, and Plants, anſwering every Occaſion and Purpoſe of Man for this Uſe, in all Ages and Places, all the World over, is a great Act of the Creator's Goodneſs; as manifeſting, that ſince he has left Man to ſhift for himſelf, it ſhould not be without ſufficient Help to enable him to do ſo, if he would but make Uſe of them, and the Senſe and Reaſon which God hath given him.

Thus ſufficient Proviſion is made for the Habitation of Man.

And no leſs ſhall we find is made for the reſt of the Creatures; who, although they want the Power of Reaſon to vary their Methods, and cannot add to, or diminiſh from, or any way make Improvements upon their Natural Way, yet we find that natural Inſtinct, which the Creator's infinite Underſtanding hath imprinted in them, to be abundantly ſufficient, nay, in all Probability, the very beſt or only Method they can take, or that can be invented, for the reſpective Uſe and Purpoſe of each peculiar Species of Animals *(b)*. If ſome Creatures make their Neſts in Houſes, ſome in Trees, ſome in Shrubs, ſome in the Earth *(c)*, ſome in Stone,

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(a) ——— *Dant utile lignum*
Navigiis Pinos, domibus Credroſque, Cupreſſoſque:
Hinc radios trivere Rotis, hinc tympana plauſtris
Agricolæ, & pandas ratibus poſuere carinas.
Viminibus Salices fæcundæ, frondibus Ulmi;
At Myrtus validis haſtilibus, & bona bello
Cornus; Ityræos Taxi torquentur in arcus.
Nec Tiliæ leves, aut torno raſile Buxum,
Non formam accipiunt, ferroque cavantur acuto:
Necnon & torrentum undam levis innatat Alnus
Miſſa Pado: necnon & apes examina condunt
Corticibuſque cavis, vitioſæque Ilicis alveo.
Virg. Georg. lib. ii. carm. 442.

(b) See *Chap.* xv. and *Book* VIII. *Chap.* vi.

(c) Many of the *Veſpæ Ichneumones* are remarkable enough for their Nidification and Proviſion for their Young. Thoſe

Stone, ſome in the Waters, ſome here, and ſome there, or have none at all; yet we find, that that Place, that Method of Nidification, doth abundantly anſwer the Creatures Uſe and Occaſions. They can there ſufficiently and well repoſe, and ſecure themſelves, lay, and breed up their Young. We are ſo far from diſcovering any Inconvenience in any of their reſpective Ways, from perceiving any Loſs befall the Species, any Decay, any periſhing of their Young; that, in all Probability, on the contrary, in that particular Way they better thrive, are more ſecure, and better able to ſhift for, and help themſelves. If, for Inſtance, ſome Beaſts make to themſelves no Habitation, but lie abroad in the open Air, and there produce their Young; in this

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that build in Earth (who commonly have golden and black Rings round their *Alvi*) having lined the little Cells, they have perforated, lay therein their Eggs, and then carry into them Maggots from the Leaves of Trees, and ſeal them up cloſe and neatly. And another *Ichneumon*, more of the *Veſpa* than *Muſca-Ichneumon* Kind, (having a little Sting in its Tail, of a black Colour) gave me the Pleaſure, one Summer, of ſeeing it build its Neſt in a little Hole in my Study-Window. This Cell was coated about with an odoriferous, reſinous Gum, collected, I ſuppoſe, from ſome Fir-Trees near; after which it laid two Eggs (I think the Number was,) and then carried in divers Maggots, ſome bigger than itſelf. Theſe it very ſagaciouſly ſealed cloſe up into the Neſt, leaving them there, doubtleſs, partly to aſſiſt the Incubation; and eſpecially for Food to the future Young, when hatched.

Of this Artifice of theſe *Ichneumons*, *Ariſtotle* himſelf takes Notice, (but I believe he was ſcarce aware of the Eggs ſealed up with the Spiders.) Οἱ δὲ Σφῆκες Ιχνεύμονες καλούμενοι, &c. *As to the* Veſpæ *called* Ichneumones, *(leſs than others) they kill* Spiders, *and carry them into their Holes, and having ſealed them up with Dirt, they therein hatch, and produce thoſe of the ſame Kind.* Hiſt. Anim. lib. v. cap. 20.

To what hath been ſaid about theſe *Ichneumon Waſps*, I ſhall add one Obſervation more, concerning the providential Structure of their Mouth in every of their Tribes, *viz.* their Jaws are not only very ſtrong, but nicely ſized, curved, and placed for gnawing, and ſcraping thoſe complete little Holes they perforate in Earth, Wood, yea, in Stone itſelf.

Caſe we find there is no Need it ſhould be otherwiſe, by Reaſon they are either taken Care of by Man (*d*), or in no Danger, as other Creatures, from Abroad. If others repoſite their Young in Holes (*e*) and Dens, and ſecure themſelves alſo therein, it is, becauſe ſuch Guard, ſuch Security, is wanting, their Lives being ſought either by the Hoſtility of Man, or to ſatisfy the Appetite of rapacious Creatures (*f*). If among Birds, ſome build their Neſts cloſe, ſome open, ſome with this, ſome with another Material, ſome in Houſes, ſome in Trees, ſome on the Ground (*g*), ſome on Rocks and Crags on high, (of which GOD himſelf hath given an Inſtance in the *Eagle*, *Job* xxxix. 27, 28.) And ſo among the Inſect and Reptile Kinds, if ſome repoſite their Eggs or Young in the Earth, ſome in Wood, ſome in Stone, ſome on one kind of Plant,

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(*d*) *Tully* having ſpoken of the Care of ſome Animals towards their Young, by which they are nurſed and brought up, ſaith, *Accedit etiam, ad nonnullorum animantium, & earum rerum quas terra gignit, conſervationem, & ſalutem, hominum etiam ſolertia & diligentia. Nam multæ & pecudes, & ſtirpes ſunt quæ ſine procuratione hominum ſalvæ eſſe non poſſunt.* Cic. de Nat. Deor. lib. ii. cap. 52.

(*e*) Prov. xxx. 29. *The Conies are but a feeble Folk, yet make they their Houſes in the Rocks.*

(*f*) See *Note (l)*.

(*g*) It is a notable Inſtinct which *Ol. Magnus* tells of the *Galli Sylveſtres*, in his Northern Country, to ſecure themſelves againſt the Cold and Storms of the Winter. *Cum nives inſtar collium terræ ſuperficiem ubique cooperiunt, ramoſque arborum diutiùs deprimunt & condenſant, certos fructus Betulæ arboris — in formâ longi Piperis vorant, & glutiunt indigeſtos: idque tantâ aviditate, ac quantitate, ut repletum guttur toto corpore majus appareat. Deinde partitis agminibus ſeſe inter medios nivium colles immergunt, præſertim in Jan. Febr. Martio, quando nives ut turbines, typhones, vel tempeſtates graviſſimæ è nubibus deſcendunt. Cúmque copertæ ſunt, — certis hebdomadis cibo in gutture collecto, egeſto, & reſumpto vivunt Venatorum canibus non produntur. — Quod ſi præſentiunt nivem imminere majorem, prædicto fructu, iterum devorato, aliud domicilium captant in eoque manent uſque ad finem Martii, &c.* Ol. Mag. Hiſt. lib. xix. cap. 33.

ſome on another, ſome in warm and dry Places, ſome in the Water, and moiſt Places, and ſome in their own Bodies only, as ſhall be ſhewn in proper Place; in all theſe Caſes it is, in all Probability, the beſt or only Method the Animal can take for the Hatching and Production of its Young, for their Supplies, Safety, or ſome other main Point of their Being or Well-being. This is manifeſt enough in many Caſes, and therefore probable in all. It is manifeſt that ſuch Animals, for Inſtance, as breed in the Waters (as not only Fiſh, but divers Inſects, and other Land-Animals do) that their Young cannot be hatched, fed, or nurſed up in any other Element. It is manifeſt alſo, That Inſects, which lay their Eggs on this, and that, and the other agreeable Tree, or Plant, or in Fleſh, *&c.* that it is by that Means their Young are fed and nurſed up. And it is little to be doubted alſo, but that theſe Matrixes may much conduce to the Maturation and Production of the Young. And ſo in all other the like Caſes of Nidification, of Heat or Cold, Wet or Dry, Expoſed or Open, in all Probability this is the beſt Method for the Animal's Good, moſt ſalutary and agreeable to its Nature, moſt for its Fecundity, and the Continuance and Increaſe of its Species; to which every Species of Animals is naturally prompt and inclined.

Thus admirable is the natural Sagacity and Inſtinct *(b)* of the irrational Animals in the Conve-

nience

(b) It is a very odd Story (which I rather mention for the Reader's Diverſion, than for its Truth) which Dr. *Lud. de Beaufort* relates: *Vir fide dignus narravit mihi, quòd cùm ſemel, animi gratiâ, nidum aviculæ ligno obturâſſet, ſeque occultâſſet, cupidus videndi, quid in tali occaſione præſtaret; illa cùm fruſtra ſæpiùs tantâſſet roſtro illud auferre, casùs admodum impatiens, abiit, & poſt aliquod temporis ſpatium reverſa eſt, roſtro gerens plantulam, quâ obturamento applicatâ, paulò poſt, illud veluti te-*

lum

nience and Method of their Habitations. And no leſs is it in the Fabrick of them. Their architectonick Skill, exerted in the Curioſity and Dexterity of their Works, and exceeding the Skill of Man to imitate; this, I ſay, deſerves as much or more Admiration and Praiſe, than that of the moſt exquiſite Artiſt among Men. For with what inimitable Art *(i)* do theſe poor untaught Creatures lay a parcel of rude and ugly Sticks and Straws, Moſs and Dirt together, and form them into commodious Neſts! With what Curioſity do they line them within, wind and place every Hair, Feather, or Lock of Wool, to guard the tender Bodies of themſelves, and their Young, and to keep them warm? And with what Art and Craft do many of them thatch over, and coat their Neſts without, to dodge and deceive the Eye of Spectators, as well as to guard and fence againſt the Injuries of Weather *(k)*? With what prodigious Subtilty do ſome

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lum eripuit tantâ vi, ut diſperſa impetu herbula, ac occaſionem ipſi, ab aviculâ ejus virtutem diſcendi, præripuerit. Coſmog. Divina, ſect. 5. cap. 1. Had he told us what the Plant was, we might have given better Credit to this Story.

(i) Of the Subtilty of Birds in Nidification, ſee *Plin. Nat. Hiſt.* lib. x. cap. 33.

(k) Among many Inſtances that might be given of this Subtilty of Birds, and other Creatures, that of the *long-tailed Titmouſe* deſerves Obſervation, who with great Art builds her Neſt with Moſſes, Hair, and the Webs of Spiders, caſt out from them when they take their Flight: *See Book* VIII. *Chap.* 4. *Note (e)*, with which the other Materials are ſtrongly tied together. Having neatly built, and covered her Neſt with theſe Materials without, ſhe thatcheth it on the Top with the *Muſcus arboreus ramoſus*, or ſuch like broad, whitiſh Moſs, to keep out Rain, and to dodge the Spectator's Eye; and within ſhe lineth it with a great Number of ſoft Feathers, ſo many, that I confeſs I could not but admire how ſo ſmall a Room could hold them, eſpecially that they could be laid ſo cloſe and handſomely together, to afford ſufficient Room for a Bird with ſo long a Tail, and ſo numerous an Iſſue as this Bird commonly

ſome foreign Birds *(l)*, not only plat and weave the fibrous Parts of Vegetables together, and curiouſly tunnel them, and commodiouſly form them into Neſts, but alſo artificially ſuſpend them on the tender Twigs of Trees, to keep them out of the Reach of rapacious Animals?

And ſo for *Inſects*, thoſe little, weak, thoſe tender Creatures; yet, what admirable Artiſts are they in this Buſineſs of Nidification! With what great Diligence doth the little *Bee* gather its Combs from various Trees *(m)* and Flowers, the *Waſp* from ſolid *(n)* Timber! And with what prodigious geometrical Subtilty do thoſe little Animals work their deep hexagonal Cells, the only proper Figure that the beſt Mathematican could chuſe for

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ly hath, which Mr. *Ray* ſaith, *(Synopſ. Method. Avium,* p. 74.*) Ova inter omnes aviculas numeroſiſſima ponit.* See more of the Neſt of this Bird, from *Aldrovand.* in *Willugh. Ornith.* p. 243.

(l) The Neſt of the *Guira tangeima,* the *Icterus minor,* and the *Jupujuba,* or whatever other Name the *American Hang-Neſts* may be called by, are of this Kind. Of which ſee *Willughby's Ornith.* lib. ii. cap. 5. ſect. 12, 13. Alſo Dr. *Grew's Muſeum Reg. Soc.* part. i. ſect. 4. cap. 4. Theſe Neſts I have divers Times ſeen, particularly in great Perfection in our R. S. Repoſitory, and in the noble and well-furniſhed *Muſeum* of my often commended Friend Sir *Hans Sloane*; and at the ſame Time I could not but admire at the neat Mechaniſm of them, and the Sagacity of the Bird, in hanging them on the Twigs of Trees, to ſecure their Eggs and Young from the *Apes.*

(m) I mention Trees, becauſe I have ſeen *Bees* gather the Gum of Fir-Trees, which at the ſame Time gave me the Pleaſure of ſeeing their Way of loading their Thighs therewith, performed with great Art and Dexterity.

(n) Waſps, at their firſt Coming, may be obſerved to frequent Poſts, Boards, and other Wood that is dry and ſound; but never any that is rotten. Theſe they may be heard to ſcrape and gnaw; and what they ſo gnaw off, they heap cloſe together between their Chin and Fore-Legs, until they have gotten enough for a Burden, which they then carry away in their Mouths, and make their Cells with.

ſuch a Combination of Houſes *(o)*! With what Accuracy do other Inſects perforate the Earth *(p)*, Wood, yea, Stone itſelf *(q)*! For which Service, the complete Apparatus of their Mouths *(r)*, and Feet *(s)*, deſerves particular Obſervation, as hath been, and will be hereafter obſerved. And fur-

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(o) Circular Cells would have been the moſt capacious: but this would by no Means have been a convenient Figure, by Reaſon much of the Room would have been taken up by Vacancies between the Circles; therefore, it was neceſſary to make Uſe of ſome of the rectilinear Figures. Among which only three could be of Uſe; of which *Pappus Alexandrin.* thus diſcourſeth: *Cum igitur tres figuræ ſunt, quæ per ſeipſas locum circa idem punctum conſiſtentem replere poſſunt, Triangulum, ſcil. Quadratum & Hexagonum, Apes illam, quæ ex pluribus angulis conſtat, ſapienter delegerunt, utpote ſuſpicantes eam plus mellis capere quàm utram vis reliquarum. At apes quidem illud tantùm quod ipſis utile eſt cognoſcunt,* viz. *Hexagonum Quadrato & Triangulo eſſe majus & plus Mellis capere poſſe nimirum equali materiâ in conſtructionem uniuſcujuſque conſumptâ. Nos verò qui plus ſapientiæ quàm Apes habere profitemur, aliquid etiam magis inſigne inveſtigabimus.* Collect. Math. lib. v.

(p) See before *Note (c)*.

(q) See *Chap.* xi. *Note (x)*.

(r) See *Chap.* xi. *Note (y)*.

(s) Among many Examples, the Legs and Feet of the *Mole-Cricket (Gryllotalpa,)* are very remarkable. The Fore-Legs are very brawny and ſtrong; and the Feet armed each with four flat ſtrong Claws, together with a ſmall Lamina, with two larger Claws, and a third with two little Claws. Which Lamina is jointed to the Bottom of the Foot, to be extended, to make the Foot wider, or withdrawn within the Foot. Theſe Feet are placed to ſcratch ſomewhat ſideways, as well as downward, after the Manner of *Moles* Feet; and they are very like them alſo in Figure.

Somewhat of this Nature, *Swammerdam* obſerves of the Worms of the *Ephemeron. To this Purpoſe,* [to dig their Cells] *the wiſe Creator hath furniſhed them,* (ſaith he) *with fit Members. For, beſides that their two Fore-legs are formed ſomewhat like thoſe of the ordinary* Moles, *or* Gryllotalpa, *he hath alſo furniſhed them with two toothy Cheeks, ſomewhat like the Sheers of* Lobſters, *which ſerve them more readily to bore the Clay.* Swammerdam's Ephem. Vit. Publiſhed by Dr. *Tyſon*, chap. 3.

ther yet; With what Care and Neatneſs do moſt of thoſe little ſagacious Animals line thoſe their Houſes within, and ſeal them up, and fence them without *(t)*! How artificially will others fold up the Leaves of Trees and Plants *(u)*; others houſe themſelves in Sticks and Straws; others glue light and floating Bodies together *(w)*, and by that Artifice make themſelves floating Houſes in the Waters,

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(t) See the before-cited *Note (c)*.

(u) They are, for the moſt Part, ſome of the *Phalænæ* Tribe which inhabit the tunnelled, convolved Leaves, that we meet with on Vegetables in the Spring and Summer. And it is a ſomewhat wonderful Artifice, how ſo ſmall and weak a Creature, as one of thoſe newly-hatched Maggots, (for doubtleſs it is they, not the Parent-Animal, becauſe ſhe emits no Web, nor hath any tectrine Art,) can be able to convolve the ſtubborn Leaf, and then bind it in that neat round Form, with the Thread or Web it weaves from its own Body; with which it commonly lines the convolved Leaf, and ſtops up the two Ends, to prevent its own falling out; and *Earwigs*, and other noxious Animals getting in.

(w) The ſeveral Sorts of *Phryganea*, or *Cadews*, in their *Nympha*, or *Maggot State*, thus houſe themſelves; one Sort in Straws, called from thence *Straw-Worms*; others in two or more Sticks laid parallel to one another, creeping at the Bottom of Brooks; others with a ſmall Bundle of Pieces of Ruſhes, Duck-weed, Sticks, &c. glued together, wherewith they float on the Top, and can row themſelves therein about the Waters, with the Help of their Feet: Both theſe are called *Cob-bait*. Divers other Sorts there are, which the Reader may ſee a Summary of, from Mr. *Willughby*, in *Raii Method. Inſect. p.* 12. together with a good, though very brief Deſcription of the *Papilionaceous* Fly, that comes from the *Cob-bait Cadew*. It is a notable architectonick Faculty, which all the Variety of theſe Animals have, to gather ſuch Bodies as are fitteſt for their Purpoſe, and then to glue them together; ſome to be heavier than Water, that the Animal may remain at the Bottom, where its Food is; (for which Purpoſe they uſe Stones, together with Sticks, Ruſhes, &c.) and ſome to be lighter than Water, to float on the Top, and gather its Food from thence. Theſe little Houſes look coarſe and ſhew no great Artifice outwardly; but are well tunnelled, and made within with a hard tough Paſte; into which the hinder Part of

ters, to tranſport themſelves at Pleaſure after their Food, or other neceſſary Occaſions of Life! And for a Cloſe, let us take the ſcriptural Inſtance of the *Spider*, *Prov.* xxx. 28. which is one of the four little Things, which, *v.* 24. *Agur* ſays, is *exceeding Wiſe*: *The Spider taketh hold with her Hands, and is in Kings Palaces* (x). I will not diſpute the Truth of

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of the Maggot is ſo fixed, that it can draw its Cell after it any where, without Danger of leaving it behind; as alſo thruſt its Body out, to reach what it wanteth; or withdraw it into its Cell, to guard it againſt Harms.

(x) Having mentioned the *Spider*, I ſhall take this Occaſion, (although it be out of the Way) to give an Inſtance of the Poiſon of ſome of them. *Scaliger*, *Exerc.* 186. relates, *That in* Gaſcony, *his Country, there are* Spiders *of that Virulency, that if a Man treads upon them, to cruſh them, their Poiſon will paſs through the very Soles of his Shoe.* Boyl. Subtil. of Efflu. chap. iv.

Mr. *Leewenhoek* put a *Frog* and a *Spider* together into a Glaſs, and having made the *Spider* ſting the *Frog* divers Times, the *Frog* dyed in about an Hour's Time. *Phil. Tranſ.* N° 272.

In the ſame *Tranſaction*, is a curious Account of the Manner how *Spiders* lay, and guard their Eggs, *viz.* they emit them not out of the hindermoſt Part of the Body, but under the upper Part of her Belly, near the Hind-Legs, &c. Alſo there is an Account of the Parts from which they emit their Webs, and divers other Things worth Obſervation, with Cuts illuſtrating the Whole.

But in *Phil. Tranſ.* N° 22. Dr. *Nath. Fairfax*, from S. *Redi*, and his own Obſervations, thinks *Spiders* not venomous; ſeveral Perſons, as well as Birds, ſwallowing them without Hurt: Which I myſelf have known in a Perſon of Learning, who was adviſed to take them medicinally at firſt, and would at any Time ſwallow them, affirming them to be ſweet, and well taſted: And not only innocuous, but they are very ſalutiferous too, in ſome of the moſt ſtubborn Diſeaſes, if the pleaſant Story in *Mouffet* be true; of a rich *London* Matron, cured of a deſperate *Tympany*, by a certain Debauchee, that hearing of her Caſe, and that ſhe was given over by the Doctors, went to her, pretending to be a Phyſician, and confidently affirmed he would cure her; which ſhe being willing to believe, agrees with him for ſo much Money, one half to be paid down, the other upon Cure. Upon which he gives her a *Spi-*

of our *Engliſh* Tranſlation of this Text, but ſuppoſing the Animal mentioned to be that which is meant; it is manifeſt that the Art of that Species of Creatures, in ſpinning their various Webs, and the Furniture their Bodies afford to that Purpoſe, are an excellent Inſtinct, and Proviſion of Nature, ſetting forth its glorious Author.

And now from this ſhort and tranſient View of the architectonick Faculty of Animals, eſpecially the Irrationals; we may eaſily perceive ſome ſuperior and wiſe Being was certainly concerned in their Creation or Original. For, how is it poſſible that an irrational Creature ſhould, with ordinary and coarſe, or indeed any Materials, be ever able to perform ſuch Works, as exceed even the Imitation of a Rational Creature? How could the Bodies of many of them, (particularly the laſt mentioned) be furniſhed with architective Materials? How could they ever diſcover them to be in their Bodies, or know what Uſe to make of them? We muſt therefore neceſſarily conclude, That the Irrationals either have Reaſon and Judgment, not only Glimmerings thereof, but ſome of its ſuperior Acts, as Wiſdom and Foreſight, Diſcretion, Art, and Care; or elſe, that they are only paſſive in the Caſe, and act by Inſtinct, or by the Reaſon of

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a *Spider*, promiſing her Cure in three Days. Whereupon, (not doubting but that he had poiſoned her, and fearing he might be called to Account for it,) he gets out of Town as faſt as he could. But inſtead of being poiſoned, ſhe ſoon recovered. After ſome Months, the Quack gets privately to Town, when he thought the Buſtle might be over; and enquiring how his Patient did, was informed of her Cure; and thereupon viſiting her, and making an Excuſe for his Abſence, he received his Pay with great Applauſe and Thanks. *Mouff. Inſect.* lib. ii. cap. 15.

Having ſaid ſo much of *Spiders*, I might here add their Flight: But of this, ſee *Book* VIII. *Chap.* iv. *Note (e)*.

ſome ſuperior Being imprinted in their Nature, or ſome Way or other, (be it how it will) congenial with them. That they are Rational, or excel Man in Art and Wiſdom, none ſurely will be ſo fooliſh as to ſay: And therefore we muſt conclude, That thoſe excellent Ends they purſue, and that admirable Art they exert, is none of their own, but owing to that infinitely-wiſe and excellent Being, of whom it may be ſaid, with Reference to the irrational, as well as rational Creatures, as it is, *Prov.* ii. 6. *The Lord giveth Wiſdom; out of his Mouth cometh Knowledge and Underſtanding.*

CHAP. XIV.

Of Animals Self-Preſervation.

HAVING thus conſidered the Food, Cloathing and Houſes of Animals; let us in this Chapter take a Glance of another excellent Proviſion, the wiſe Creator hath made for the Good of the animal World; and that is, the Methods which all Animals naturally take for their *Self-Preſervation* and *Safety*. And here it is remarkable, (as in the Caſes before,) that *Man*, who is endowed with Reaſon, is born without Armature, and is deſtitute of many Powers, which irrational Creatures have in a much higher Degree than he, by Reaſon he can make himſelf Arms to defend himſelf, can contrive Methods for his own Guard and Safety, can many Ways annoy his Enemy, and ſtave off the Harms of noxious Creatures.

But for others, who are deſtitute of this ſupereminent Faculty; they are ſome Way or other provided with ſufficient Guard *(a)*, proportionate to their Place of Abode, the Dangers they are like to incur there *(b)*; and in a Word, to their greateſt Occa-

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(a) Callent in hoc cuncta animalia, ſciuntque non ſua modò commoda, verùm & hoſtium adverſa; nôrunt ſua tela, nôrunt occaſiones, parteſque diſſidentium imbelles. In ventre mollis eſt tenuiſque cutis Crocodilo: ideoque ſe, ut territi, mergent Delphini, ſubeunteſque alvum illa ſecant ſpinâ. Plin. Nat. Hiſt. lib. viii. cap. 25.

(b) Omnibus aptum eſt Corpus Animæ moribus & facultatibus: Equo fortibus ungulis & jubâ eſt ornatum (etenim velox & ſuperbum & generoſum eſt animal.) Leoni autem, utpote animoſo & feroci, *dentibus*

Occaſions and Need of Security. Accordingly, ſome are ſufficiently guarded againſt all common Dangers, by their natural Cloathing; by their Armature of Shells, or ſuch like hard, and impregnable Covering of their Body *(c)*. Others deſtitute of this Guard, are armed, ſome with Horns *(d)*, ſome with ſharp Quills and Prickles *(e)*, ſome with Claws,

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dentibus & unguibus validum. Ita autem & Tauro & Apro; illi enim Cornua, huic exerti Dentes.—Cervo autem & Lepori (timida enim ſunt animalia) velox corpus, ſed inerme. Timidis enim velocitas, arma audacibus conveniebant—Homini autem (ſapiens enim eſt—) manus dedit, inſtrumentum ad omnes artes neceſſarium, paci non minùs quàm bello idoneum. Non igitur indiguit Cornu ſibi innato cùm meliora Cornibus arma manibus, quandocunque volet, poſſit accipere: Etenim Enſis & Haſta majora ſunt Arma, & ad incidendum promptiora—Neque Cornu, neque Ungulæ quicquam niſi cominùs agere poſſunt; Hominum verò arma eminùs juxtà ac cominùs agunt; telum quidem & ſagitta magis quam cornua.—Non igitur eſt nudus, neque inermis.—Sed ipſi eſt Thorax ferreus, quandocunque libet, omnibus Coriis difficilius ſauciatu organum.—Nec Thorax ſolum ſed & Domus, & Murus, & Turris, &c. Galen. de Uſ. Part. lib. i. cap. 2.

(c) Shells deſerve a Place in this Survey, upon the Account of their great Variety; the curious and uncouth Make of ſome, and the beautiful Colours, and pretty Ornaments of others; but it would be endleſs to deſcend to Particulars. Omitting others, I ſhall therefore only take Notice of the *Tortoiſe-Shell*, by Reaſon a great deal of Dexterity appears, even in the Simplicity of that Animal's Skeleton. For, beſides that, the Shell is a ſtout Guard to the Body, and affords a ſafe Retreat to the Head, Legs, and Tail, which it withdraws within the Shell upon any Danger; beſides this, I ſay, the Shell ſupplieth the Place of all the Bones in the Body, except thoſe of the extreme Parts, the Head and Neck, and the four Legs and Tail. So that at firſt Sight, it is ſomewhat ſurpriſing to ſee a complete Skeleton conſiſting of ſo ſmall a Number of Bones, and they abundantly ſufficient for the Creature's Uſe.

(d) Dente timentur Apri: defendunt cornua Tauros:
Imbelles Damæ quid niſi præda ſumus?
Martial. l. xiii. Epigr. 94.

(e) The *Hedgehog* being an helpleſs, ſlow, and patient Animal, is accordingly guarded with Prickles, and a Power of rolling

Claws, ſome with Stings *(f)*; ſome can ſhift and change their Colours *(g)*; ſome can make their Eſcape by the Help of their Wings, and others by the

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rolling itſelf up in them. *Clavis terebrari ſibi pedes, & diſcindi viſcera patientiſſimè ferebat, omnes cultri ictus ſine gemitu pluſquam Spartanâ nobilitate concoquens.* Barrichius in Blaſ. de Echino. *Panniculum carnoſum amplexabatur Muſculus penè circularis, admirandæ fabricæ, lacinias ſuas ad pedes, caudam, caput, variè exporrigens, cujus miniſterio Echinus ſe ad arbitrium in orbem contrahit.* Act. Dan. in Blaſio.

Iſte licèt digitos teſtudine pungat acutâ,
Cortice depoſito mollis Echinus erit. Mart. l. xiii. Epig. 86.

(f) The *Sting* of a *Waſp*, or *Bee*, &c. is ſo pretty a Piece of Work, that it is worth taking Notice of, ſo far as I have not found others to have ſpoken of it. Others have obſerved the Sting to be an hollow Tube, with a Bag of ſharp penetrating Juices, (its Poiſon,) joined to the End of it, within the Body of the *Waſp*, which is, in Stinging, injected into the Fleſh through the Tube. But there are, beſides this, two ſmall, ſharp, bearded Spears, lying within this Tube, or Sting, as in a Sheath. In a *Waſp*'s Sting, I counted eight Beards on the Side of each Spear, ſomewhat like the Beards of Fiſh-hooks. Theſe Spears in the Sting, or Sheath, lie one with its Point a little before that of the other; as is repreſented in *Fig.* 21. to be ready (I conceive) to be firſt darted into the Fleſh; which being once fixed, by Means of its foremoſt Beard, the other then ſtrikes in too, and ſo they alternately pierce deeper and deeper, their Beards taking more and more hold in the Fleſh; after which the Sheath or Sting follows, to convey the Poiſon into the Wound. Which, that it may pierce the better, it is drawn into a Point, with a ſmall Slit a little below that Point for the two Spears to come out at. By means of this pretty Mechaniſm in the Sting, it is, that the Sting when out of the Body, and parted from it, is able to pierce and ſting us: And by Means of the Beards being lodged deep in the Fleſh, it comes to paſs that *Bees* leave their Stings behind them, when they are diſturbed before they have Time to withdraw their Spears into their Scabbard. In *Fig.* 21. is repreſented the two Spears as they lie in the Sting. In *Fig.* 22. the two Spears are repreſented when ſqueezed out of the Sting, or the Scabbard; in which Latter, *Fig. A c b*, is the Sting, *c d*, and *b e*, the two bearded Spears thruſt out.

(g) The *Camelion* is ſufficiently famed on this Account. Beſides which, *Pliny* tells us of a Beaſt as big as an *Ox*, called the *Tarandus*, that, when he pleaſeth, aſſumes the Colour of

the Swiftneſs of their Feet; ſome can ſcreen themſelves by diving in the Waters; others by tinging and diſordering the Waters *(h)*, can make their Eſcape; and ſome can guard their Bodies even in the very Flames, by the Ejections of the Juice of their Bodies *(i)*; and ſome by their accurate Smell, Sight, or Hearing, can foreſee Dangers *(k)*; others by

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of an *Aſs*, and *Colorem omnium fruticum, arborum, florum, locorumque reddit, in quibus latet metuens, ideoque rarò capitur.* Plin. lib. viii. cap. 34.

How true this is, there may be ſome Reaſon to doubt; but if any Truth be in this Story, it may be from the Animal's chuſing ſuch Company, or Places, as are agreeable to its Colour: As I have ſeen in divers *Caterpillars*, and other Inſects, who I believe were not able to change their Colour, from one Colour to another; yet I have conſtantly obſerved, do fix themſelves to ſuch Things as are of the ſame Colour; by which Means they dodge the Spectator's Eye. Thus the *Caterpillar* that feeds on *Elder*, I have more than once ſeen, ſo cunningly adhering to the ſmall Branches of the ſame Colour, that it might be eaſily miſtaken for a ſmall Stick, even by a careful View. So a large green *Caterpillar*, that feeds on *Buckthorn*, and divers others. To which I may add, the prodigious Sagacity of the *Ichneumon Flies*, that make the *Kermes*, (for of that Tribe all the *Kermes* I ever ſaw was;) how artificially they not only incloſe their Eggs within that gummy Skin, or Shell, but alſo ſo well humour the Colour of the Wood they adhere to, by various Streaks and Colours, that it is not eaſy to diſtinguiſh them from the Wood itſelf.

(h) Contra metum & vim, ſuis ſe armis quæque defendit. Cornibus Tauri, Apri dentibus, morſu Leones, aliæ fugâ ſe, aliæ occultatione tutantur: atramenti effuſione Sepiæ, torpore Torpedines. Multæ etiam inſectantes odoris intolerabili fœditate depellunt. Cic. de Nat. Deor. lib. ii. cap. 50.

(i) A Knight, called *Corvini*, at *Rome*, caſt a *Salamander* into the Fire, which preſently ſwelled, and then vomited Store of thick ſlimy Matter, which put out the Coals; to which the *Salamander* preſently retired, putting them out again in the ſame Manner, as ſoon as they re kindled, and by this Means ſaved itſelf from the Force of the Fire, for the Space of two Hours; after which it lived nine Months. *Vide Philoſ. Tranſ.* N°. 21. in *Lowth. Abridg.* vol. ii. p. 816.

(k) Pliny gives an Inſtance in each, lib. x. cap. 69. *Aquilæ*

by their natural Craft, can prevent or eſcape them (*l*); others by their uncouth Noiſe (*m*); by the horrid Aſpect, and ugly Geſticulations of their Body (*n*); and ſome even by the Power of their Excrements, and their Stink (*o*), can annoy

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clariùs cernunt [quàm homines]; *Vultures ſagaciùs odorantur: liquidiùs audiunt Talpæ obrutæ terrâ, tam denſo atque ſurdo naturæ elemento.*

(*l*) The *Doublings* of the *Hare*, before ſhe goes to Form, thereby to dodge and deceive the *Dogs*, although a vulgar Obſervation, is a notable Inſtinct for an Animal, leſs famed for Cunning than the *Fox*, and ſome others.

(*m*) It is natural for many Quadrupeds, Birds, and Serpents, not only to put on a torvous angry Aſpect, when in Danger, but alſo to ſnarl, hiſs, or by ſome other Noiſe deter their Adverſary.

(*n*) The *Iynx* or *Wryneck*, although a Bird of very beautiful Feathers, and conſequently far enough off from being any way terrible; yet, being in Danger, hath ſuch odd Contortions of its Neck, and Motions of its Head, that I remember have ſcared me, when I was a Boy, from taking their Neſts, or touching the Bird, daring no more to venture my Hand into their Holes than if a Serpent had lodged in it.

(*o*) *Bonaſus tuetur ſe calcibus & ſtercore, quod ab ſe quaternis paſſibus* [trium jugerum longitudine. *Plin. Nat. Hiſt.* lib. viii. cap. 15.] *ejaculatur, quod ſæpe comburit adeò ut deglabrentur canes.* Ray's Synopſ. Quadr. p. 71.

Camelus Peruvianus Clama dictus neminem offendit, ſed miro admodum ingenio ſe ab illatâ vindicat injuriâ, nimirum vomitu vel cibi, vel humoris in vexantem retrorſum cum impetu ejaculato, ob protenſam colli longitudinem. Id. ib. p. 146.

Tzquiepatl, (Anglicé *Squnck*, Præf. and one that I ſaw they called a *Stonck*,) *Cùm quis eam inſectatur, fundit cum ventris crepitu halitum fœtidiſſimum: quin ipſa tota terrimum exhalat odorem, & urina ſtercuſque eſt fœtidiſſimum, atque adeò peſtilens, ut nihil ſit reperire in noſtro orbe, cui in hâc re poſſit comparari: quo ſit, ut in periculo conſtituta, urinam & fæces ad* 8 *pluriumve paſſuum intervallum ejiciat, hoc modo ſe ab omnibus vindicans injuriis, ac veſtes inficiens maculis luteis indelebilibus, & nunquam ſatis perſpirante odore: aliàs innoxium Animal eduleque, hâc ſolâ ratione horrendiſſimum.* Id. ib. p. 182.

Si Accipiter Ardeam in ſublimi moleſtat, ſtercore immiſſo in pennas ejus eas putreſcere facit: uti Solinus ſcribit de Bonaſo, &c. Ita et Lupus urinam ſpargit in perſequentem. Ol. Mag. Hiſt. lib. xix. cap. 14.

their Enemy, and ſecure themſelves; and againſt ſome *(p)*, the Divine Providence itſelf hath provided a Guard.

By ſuch Shifts and Means as theſe, a ſufficient Guard is miniſtred to every Species of Animals, in its proper reſpective Place; abundantly enough to ſecure the Species from Deſtruction, and to keep up that Balance, which, I have formerly ſhewed, is in the World, among every, and all the Species of Animals; but yet not enough to ſecure Individuals, from becoming a Prey to Man, or to other Creatures, as their Neceſſities of Life require. To which Purpoſe, the natural Sagacity and Craft of the one intrapping *(q)*, and captivating, being in ſome Meaſure equivalent to that of the other in evading, is as excellent a Means for the maintaining the one, as preſerving the other; and, if well conſidered, argues the Contrivance of the infinitely wiſe Creator and Preſerver of the World.

(p) Thus againſt the *Crocodile*, which can catch its Prey only before it, not on one Side. So the *Shark*, of which take my often recommended Friend Sir *Hans Sloane*'s Obſervation; *It hath this particular to it, with ſome others of its own Tribe, that the Mouth is in its under Part, ſo that it muſt turn the Belly upwards to Prey. And was it not for that Time it is in turning, in which the purſued Fiſhes eſcape, there would be nothing that could avoid it; for it is very quick in Swimming, aud hath a vaſt Strength, with the largeſt Swallow of any Fiſh, and is very devouring.* Sloane's Voyage to Jamaica, p. 23.

(q) See *Chap.* xi. *Note (iii).*

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CHAP. XV.

Of the Generation of Animals.

THere remains now only one Thing more of the ten Things in common to Animals, and that is what relates to their Generation *(a)*, and Conſervation

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(a) Spontaneous Generation, is a Doctrine ſo generally exploded, that I ſhall not undertake the Diſproof of it. It is evident, that all Animals, yea, Vegetables too, owe their Production to Parent-Animals and Vegetables; that I have often admired at the Sloth and Prejudices of the Antient Philoſophers, in ſo eaſily taking upon Truſt the *Ariſtotelian,* or rather, the *Egyptian* Doctrine of *Equivocal Generation*; that when they ſaw *Flies, Frogs,* and *Lice,* for Inſtance, to be Male and Female, and accordingly to ingender, lay Eggs, *&c.* they could ever imagine any of theſe Creatures ſhould be ſpontaneouſly produced, eſpecially in ſo Romantick a Manner, as in the Clouds; as they particularly thought *Frogs* were, and that they dropped down in Showers of Rain. For an Anſwer to this Caſe of *Frogs,* I ſhall refer to a Relation of my own, which my late moſt ingenious and learned Friend, the great Mr. *Ray,* requeſted of me, and was pleaſed to publiſh in his laſt Edition of his *Wiſdom of God manifeſted,* &c. p. 365.

But ſome will yet aſſert the Raining of *Frogs*; among which the curious Dr. *Plot* is ſomewhat of this Opinion: telling us of *Frogs* found on the Leads of the Lord *Aſton's* Gate-houſe, at *Tixal* in *Staffordſhire,* which he thinks by ſome ſuch Means came there; as alſo on the Bowling Green, frequently after a Shower of Rain. *Plot's Hiſt. Staff.* chap. i. *ſect.* 47.

But we may take a Judgment of this, and an Hundred ſuch like Reports, to be met with in conſiderable Authors, from other the like Reports that have been better inquired into. In a Scarcity in *Sileſia,* a mighty Rumour was ſpread of its *raining Millet-Seed*; but the Matter being enquired into, it was found to be only the Seeds of the *Ivy-leaved Speedwell,* or *Small Henbit,* growing in the Place in great Plenty. *Eph. Germ. An.* 3. *Obſ.* 40. So in the *Archipelago,* it was thought Aſhes were rained, Ships being covered therewith at a hundred Leagues

Diſtance; but, in all Probability, it was from an Eruption of *Veſuvius*, that then happened. About *Warminſter* in *Wilts*, it was reported it *rained Wheat*; but a curious Obſerver, Mr. *Cole*, found it to be only *Ivy-Berries*, blown thither in a conſiderable Quantity by a Tempeſt. In the Year 1696, at *Cranſtead* near *Wrotham* in *Kent*, a Paſture-Field was over-ſpread with little young *Whitings*, ſuppoſed to fall from the Clouds, in a Tempeſt of Thunder and Rain; but doubtleſs they were brought thither with Waters from the Sea by the Tempeſt. See the before-commended Mr. *Lowth. Abridg. Phil. Tranſ.* Vol. ii. p. 143, 144.

Neither needeth it ſeem ſtrange, that *Aſhes*, *Ivy-Berries*, ſmall *Fiſhes*, or young *Frogs*, (which yet may have ſome other Conveyance,) ſhould be thus tranſported by tempeſtuous Winds, conſidering to what Diſtance, and in what Quantities, the Sea-Waters were carried by the *Great Storm*, *Novemb.* 26, 1703, of which an ingenious Friend ſent me theſe Accounts from *Lewes* in *Suſſex*, viz. *That a Phyſician travelling ſoon after the Storm, to* Tiſehurſt, *twenty Miles from the Sea, as he rode along plucked ſome Tops of Hedges, and chewing them, found them Salt: That ſome* Grapes *hanging on the Vines at* Lewes, *were ſo too. That Mr.* Williamſon, *Rector of* Ripe, *found the Twigs in his Garden ſalt the* Monday *after the Storm; and others obſerved the ſame a Week after. That the Graſs of the Downs about* Lewes, *was ſo Salt, that the Sheep would not feed till Hunger compelled them: And that the* Miller *of* Berwick, *(three Miles from the Sea,) attempting with his Man to ſecure his Mill, were ſo waſhed with Flaſhes of Sea Water, like the Breakings of Waves againſt the Rocks, that they were almoſt ſtrangled therewith, and forced to give over their Attempt.*

I called this Doctrine of *Equivocal Generation*, an *Egyptian Doctrine*, becauſe probably it had its Riſe in *Egypt*, to ſalve the Hypotheſis of the Production of Men, and other Animals, out of the Earth, by the Help of the Sun's Heat. To prove which, the *Egyptians* (as *Diod. Sicul.* ſaith) *produce this Obſervation, That about* Thebes, *when the Earth is moiſtened by the* Nile, *by the Intenſe Heat of the Sun, an innumerable Number of* Mice *do ſpring out.* From whence he infers, that all Kinds of Animals, might as well at firſt come likewiſe out of the Earth. And from theſe the learned Biſhop *Stillingfleet* thinks other Writers, as *Ovid*, *Mela*, *Pliny*, &c. have, without examining its Truth, taken up the ſame Hypotheſis. *Vide Stillingfleet's Orig. Sacr.* part II. book i. chap. 1.

The before commended Dr. *Harris*, from the Obſervations of Dr. *Harvey*, *S. Malpighi*, Dr. *De Graaf*, and Mr. *Leewenhoeck*, infers three Things concerning *Generation*, as highly probable. 1. *That Animals are* ex Animalculo. 2. *That the* Animalcules *are originally* in ſemine Marium, & non in Fœmivation of their Species *(b)*, by that Means. It would not be ſeemly to advance far in this admirable Work of God; neither ſhall I at all inſiſt upon that of Man, for the ſame Reaſon. And as for the Irrationals *(c)*, I ſhall confine myſelf to theſe five Matters.

I. Their natural Sagacity in chuſing the fitteſt Places to repoſite their Eggs and Young.

II. The fitteſt Times and Seaſons they make uſe of for their Generation.

III. The due and ſtated Number of their Young.

IV. Their Diligence and earneſt Concern in their Breeding up.

V. Their Faculty of Feeding them, and their Art and Sagacity exerted therein.

I. The natural Sagacity of irrational Animals, in chuſing the fitteſt Places to repoſite their Eggs and Young. Of this I have given larger Hints already than I needed to have done, when I ſpake of the Architecture *(d)* of Animals, intending then to have wholly paſſed by this Buſineſs of Generation: I ſhall therefore now only ſuperadd a few other Inſtances, the more to illuſtrate this Matter:

It hath been already ſhewn, and will hereafter *(e)*

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nis. 3. *That they can never come forward, or be formed into Animals of the reſpective Kind, without the* Ova in Fœminis. His Proofs and Illuſtration, ſee under the Word *Generation*, in his *Lex. Techn.* vol. ii.

(b) At certè Natura, ſi fieri potuiſſet, maximè optâſſet ſuum opificium eſſe immortale: quod cùm per materiam non liceret (nam quod — ex carne eſt compoſitum, incorruptibile eſſe non poteſt) ſubſidium quod potuit ipſi ad immortalitatem eſt fabricata, ſapientis cujuſdam urbis conditoris exemplo, &c. Nam mirabilem quandam rationem invenit, quomodo in demortui animalis locum, novum aliud ſufficiat. Galen. de Uſu Part. lib. xiv. cap. 22.

(c) Animantia Bruta Obſtetricibus non indigent in edendo Partu, cùm inditâ Naturæ-vi Umbilicus ſeipſum occludat. Ol. Rudbeck in Blaſii Anat. Felis.

(d) Chap. xiii.

(e) Book VIII. *Chap.* 6.

farther appear, that the Places in which the ſeveral Species of Animals lay up their Eggs, and Young, are the beſt for that Purpoſe; Waters *(f)* for one; Fleſh for another; Holes in Wood *(g)*, Earth, or Stone *(h)*, for others; and Neſts for others; and we ſhall find, that ſo ardent is the Propenſity of all Animals, even of the meaneſt Inſects, to get a fit Place for the Propagation of their Young, that, as will hereafter appear, there is ſcarce any Thing that eſcapeth the Inqueſt of thoſe little ſubtile Creatures. But beſides all this, there are two or three Things more obſervable, which plainly argue the Inſtinct of ſome ſuperior rational Being. As,

1. The complete and neat Order which many Creatures obſerve in laying up their Seed, or Eggs,

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(f) The *Ephemeron*, as it is an unuſual and ſpecial Inſtance of the Brevity of Life, ſo I take it to be a wonderful Inſtance of the ſpecial Care and Providence of God, in the Conſervation of the Species of that Animal. For, 1. As an Animal, whoſe Life is determined in about five or ſix Hours Time, (*viz.* from about Six in the Evening, till about Eleven o'Clock at Night) needs no Food; ſo neither doth the *Ephemeron* eat, after it is become a *Fly*. 2. As to its Generation; in thoſe five Hours of its Life, it performs that, and all other neceſſary Offices of Life: For in the Beginning of its Life, it ſheds its Coat; and that being done, and the poor little Animal thereby rendered light and agile, it ſpends the reſt of its ſhort Time in friſking over the Waters, and at the ſame Time the Female droppeth her Eggs on the Waters, and the Male his Sperm on them, to impregnate them. Theſe Eggs are ſpread about by the Waters; deſcend to the Bottom by their own Gravity; and are hatched by the Warmth of the Sun, into little Worms, which make themſelves Caſes in the Clay, and feed on the ſame without any need of parental Care. *Vide Ephem. vita*, tranſlated by Dr. *Tyſon* from *Swammerdam*. See alſo *Book* VIII. *Chap.* 6. *Note (r)*.

(g) See *Chap.* xiii. *Note (c)*, and *Book* VIII. *Chap.* 6.

(h) The *Worms* in *Chap.* 11. *Note (x)* breed in the Holes they gnaw in Stone, as is manifeſt from their Eggs found therein.

in proper Repoſitories: Of which I ſhall ſpeak in another Place *(i)*.

2. The ſuitable Apparatus in every Creature's Body, for the laying up its Eggs, Seed, or Young, in their proper Place. It would be as endleſs as needleſs to name all Particulars, and therefore an Inſtance or two of the Inſect-Tribe, may ſerve for a Specimen in this Place, till I come to other Particulars. Thus Inſects, who have neither Feet adapted to ſcratch, nor Noſes to dig, nor can make artificial Neſts to lay up their Young; yet what abundant Amends is there made them, in the Power they have either to extend the *Abdomen (k)*, and there-

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(i) See *Book* VIII. *Chap.* vi. *Note (q)*.

(k) Many, if not moſt Flies, eſpecially thoſe of the *Fleſh-Fly* Kind, have a Faculty of extending their *Uropygia*, and thereby are enabled to thruſt their Eggs into convenient Holes and Receptacles for their Young in Fleſh, and whatever elſe they fly-blow; but none more remarkable than the *Horſe Fly*, called by *Pennius* in *Mouffet*, (p. 62.) Σκολιοῦρος, i. e. *Curvicauda*, and the *Whame*, or *Burrel-Fly*, which is vexatious to Horſes in Summer, not by ſtinging them, but only by their bombylious Noiſe, or tickling them in ſticking their Nits, or Eggs, on the Hair; which they do in a very dexterous Manner, by thruſting out their *Uropygia*, bending them up, and by gentle, ſlight Touches, ſticking the Eggs to the Hair of the Legs, Shoulders, and Necks, commonly of Horſes; ſo that Horſes which go abroad, and are ſeldom dreſſed, are ſomewhat diſcoloured by the numerous Nits adhering to their Hair.

Having mentioned ſo much of the Generation of this Inſect, although it be a little out of the Way, I hope I ſhall be excuſed for taking Notice of the long-tailed Maggot, which is the Product of theſe Nits or Eggs, called by Dr. *Plot*, *Eruca Glabra*, [or rather *Eula Scabra*, it ſhould be] *Caudata Aquatico-arborea*, it being found by him in the Water of an hollow Tree; but I have found it in Ditches, Saw-Pits, Holes of Water in the High-way, and ſuch-like Places where the Waters are moſt ſtill and foul. This Maggot I mention, as being a ſingular and remarkable Work of God, not ſo much for its being ſo utterly unlike as it is to its Parent *Bee*-like Fly, as for the wiſe Proviſion made for it by its long Tail; which is ſo jointed thereby reach the commodious Places they could not otherwiſe come at; or elſe they have ſome aculeous Part or Inſtrument to terebrate, and make Way for their Eggs into the Root *(l)*, Trunk *(m)*, Fruit,

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at certain Diſtances from the Body, as that it can be withdrawn, or ſheathed, one Part within another, to what Length the Maggot pleaſeth, ſo as to enable it to reach the Bottom of very ſhallow, or deeper Waters, as it hath Occaſion, for the gathering of Food. At the End of this Tapering is a Ramification of *Fibrillæ*, or ſmall Hairs, repreſenting, when ſpread, a Star; with the Help of which, ſpread out on the Top of the Waters, it is enabled to hang, making, by that Means, a ſmall Depreſſion or Concavity on the Surface of the Water. In the Midſt of this Star, I imagine the Maggot takes in Air, there being a Perforation, which with a Microſcope I could perceive to be open, and by the Star to be guarded againſt the Incurſion of the Water.

(l) The Excreſcences on the Root of *Cabbages*, *Turneps*, and divers other Plants, have always a Maggot in them; but what the Animal is that thus makes its Way to the Root under Ground, whether *Ichneumon*, *Phalæna*, *Scarab*, or *Scolopendra*, I could never diſcover, being not able to bring them to any Thing in Boxes.

(m) I preſume there are only of the *Ichneumon-Fly* Kind, that have their Generation in the Trunks of Vegetables. In *Malpighi de Gallis*, *Fig.* 61. is a good Cut of the gouty Excreſcences, or rather Tumours, of the *Briar-Stalk*: from which proceeds a ſmall black *Ichneumon-Fly*, with red *Legs*; black, ſmooth-jointed *Antennæ*; pretty large *Thorax*; and ſhort, round *Belly*, of the Shape of a Heart. It leapeth as a *Flea*. The *Male* (as in other Inſects) is leſſer than the *Female*, and very venerous, in ſpite of Danger, getting upon the *Female*, whom they beat and tickle with their Breeches and Horns, to excite them to a *Coit*.

Another Example of the Generation in the Trunks of Vegetables, ſhall be from the Papers of my often-commended Friend Mr. *Ray*, which are in my Hands, and that is an Obſervation of the ingenious Dr. *Nathaniel Wood*: *I have* (ſaid he) *lately obſerved many Eggs in the common Ruſh; one Sort are little tranſparent Eggs, in Shape ſomewhat like a Pear, or Retort, lying within the Skin, upon, or in the* Medulla, *juſt againſt a browniſh Spot on the out-ſide of the Ruſh; which is apparently the Creatrix of the Wound made by the Fly, when ſhe puts her Eggs there. Another Kind is much longer, and not ſo tranſparent, of a long Oval,* or

Fruit *(n)*, Leaves *(o)*, and the tender Buds of Vegetables *(p)*, or ſome other ſuch curious and ſecure Method they are never deſtitute of. To which we may add,

3. The natural Poiſon *(q)*, (or what can I call it?) which many, or moſt of the Creatures, laſt intended, have, to cauſe the Germination of ſuch Balls, Caſes, and other commodious Repoſitories,

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or rather cylindrical Form; ſix, eight, or more, lie commonly together, acroſs the Ruſh, parallel to each other, like the Teeth of a Comb, and are as long as the Breadth of the Ruſh. Letter from *Kilkenny* in *Ireland, April* the 28th, 1697.

(n) See *Book* VIII. *Chap.* vi. *Note (d).*

(o) I have, in *Chap.* xiii. *Note (u),* and *Book* VIII. *Chap.* vi. *Note (e), (f),* taken Notice of the Nidification and Generation of ſome Inſects on the Leaves of Vegetables, and ſhall therefore, for the Illuſtration of this Place, chuſe an uncommon Example out of the *Scarab* Kind (the Generation of which Tribe hath not been as yet mentioned), and that is, of a ſmall *Scarab* bred in the very Tips of *Elm-Leaves.* Theſe Leaves, in Summer, may be obſerved to be, many of them, dry and dead, as alſo turgid; in which lieth a dirty, whitiſh, rough Maggot, from which proceeds a *Beetle* of the ſmalleſt Kind, of a light, *Weeſle* Colour, that leapeth like a *Graſhopper,* although its Legs are but ſhort. Its Eyes are blackiſh, *Elytra* thin, and prettily furrowed, with many Concavities in them; ſmall club-headed *Antennæ,* and a long *Roſtrum* like a *Proboſcis.*

The ſame, or much like this, I have met with on Tips of *Oaken* and *Holly-Leaves.* How the *Scarab* lays its Eggs in the Leaf, whether by terebrating the Leaf, or whether the *Maggot,* when hatched, doth it, I could never ſee. But with great Dexterity, it makes its Way between the upper and under Membranes of the Leaf, feeding upon the parenchymous Part thereof. Its Head is ſlenderer and ſharper than moſt of *Maggots,* as if made on Purpoſe for this Work; but yet I have often wondered at their Artifice, in ſo nicely ſeparating the Membranes of the *Elm Leaf,* without breaking them, and endangering their own tumbling out of them, conſidering how thin, and very tender, the Skins of that Leaf (particularly) are.

(p) See *Book* VIII. *Chap.* vi. *Note (x).*

(q) See *Book* VIII. *Chap.* viii. to *Note (bb),* &c.

as are an admirable Lodgment to the Eggs and Young; that particularly aſſiſt in the Incubation and Hatching the Young, and then afford them ſufficient Food and Nouriſhment in all their *Nympha-State*, in which they need Food; and are afterwards commodious Houſes and Beds for them in their *Aurelia-State*, till they are able to break Priſon, fly abroad, and ſhift for themſelves. But this ſhall be taken Notice of, when I come to treat of Inſects.

II. As irrational Animals chuſe the fitteſt Place, ſo alſo the fitteſt Times and Seaſons for their Generation. Some indeed are indifferent to all Times, but others make uſe of peculiar Seaſons *(r)*. Thoſe, for Inſtance, whoſe Proviſions are ready at all Seaſons, or who are under the Tuition of Man, produce their Young without any great Regard to Heat or Cold, Wet or Dry, Summer or Winter. But others, whoſe Proviſions are peculiar, and only to be met with at certain Seaſons of the Year; or who, by their Migration, and Change of Place, are tied up to certain Seaſons; theſe (as if endowed with a natural Care and Foreſight of what ſhall happen) do accordingly lay, hatch, and nurſe up their Young in the moſt proper Seaſons of all the Year for their Purpoſe; as in Spring, or Summer, the Times of Plenty of Proviſions, the Times of Warmth for Incubation, and the moſt proper Seaſons to breed up their Young, till they are able to ſhift for themſelves, and can range about for Food, and ſeek Places of Retreat and Safety, by flying long Flights as well as their Progenitors, and paſſing into far diſtant Regions, which (when

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(r) Πολλὰ δὲ ϗ πρὸς ἐκτροφὰς τῶν τέκνων στοχαζόμενα, ποιοῦνται τὸν συνδυασμὸν ἐν τῇ ἀπαρτιζούσῃ ὥρᾳ. Ariſt. Hiſt. Anim. lib. v. cap. 8. ubi ſupra.

others fail) afford thoſe helpleſs Creatures the Neceſſaries of Life.

III. To the ſpecial Seaſons, I may add the peculiar Number of Young produced by the irrational Creatures. Of which I have already taken ſome Notice, when I ſpake of the Balance of Animals *(s)*. Now, if there was not a great deal more than Chance in this Matter, even a wiſe Government of the Creation, it could never happen that every Species of Animals ſhould be tied up to a certain Rate and Proportion of its Increaſe; the moſt uſeful would not be the moſt fruitful, and the moſt pernicious produce the feweſt Young, as I have obſerved it commonly is. Neither would every Species produce ſuch a certain Rote as it is only able to breed up: But all would be in a confuſed, huddled State. Inſtead of which, on the contrary, we find every Thing in complete Order; the Balance of *Genera*, Species and Individuals always proportionate and even; the Balance of Sexes the ſame; moſt Creatures tied up to their due Stint and Number of Young, without their own Power and Choice, and others (particularly of the winged *(t)* Kind) producing their due Number at Choice and Pleaſure; ſome large Numbers, but not more than

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(s) See *Chap.* x.

(t) Mr. *Ray* alledges good Reaſon to conclude, That although Birds have not an exact Power of numbering, yet, that they have of diſtinguiſhing many from few, and knowing when they come near to a certain Number; and that they have it in their Power to lay many or few Eggs. All which he manifeſteth from *Hens*, and other domeſtic Fowls, laying many more Eggs when they are withdrawn, than when not. Which holds in wild as well as domeſtic Birds, as appears from Dr. *Liſter*'s Experiment in withdrawing a *Swallow*'s Egg, which by that Means laid nineteen Eggs ſucceſſively before ſhe gave over. *Vide* Ray's *Wiſdom of God*, &c, p. 137.

they can cover, feed and foſter; others fewer, but as many as they can well nurſe and breed up. Which minds me,

IV. Of the Diligence and earneſt Concern which irrational Animals have of the Production and Breeding up their Young. And here I have already taken Notice of their Στοργὴ, or natural Affection, and with what Zeal they feed and defend their Young. To which may be added theſe two Things:

1. The wonderful Inſtinct of Incubation. It is utterly impoſſible, that ever unthinking, untaught Animals ſhould take to that only Method of hatching their Young, was it not implanted in their Nature by the infinitely wiſe Creator. But ſo ardent is their Deſire, ſo unwearied is their Patience when they are engaged in that Buſineſs, that they will abide on their Neſts for ſeveral Weeks, deny themſelves the Pleaſures, and even the Neceſſaries of Life; ſome of them even ſtarving themſelves almoſt, rather than hazard their Eggs to get Food; and others either performing the Office by Turns *(u)*, or elſe the one kindly ſeeking out, and carrying Food to the other *(w)*, engaged in the Office of Incubation.

(u) Palumbes incubat fœmina poſt meridiana in matutinum, cætero mas. Columbæ incubant ambo, interdiu Mas, noctu Fœmina. Plin. Nat. Hiſt. lib. x. cap. 58.

(w) Of the common *Crow*, Mr. *Willughby* ſaith, *The Females only ſit, and that diligently, the Males in the mean Time bring them Victuals; as* Ariſtotle *ſaith. In moſt other Birds, which pair together, the Male and Female ſit by Turns.* Ornithol. lib. ii. ſect. 1. cap. 2. ſect. 2. And I have obſerved the Female-Crows to be much fatter than the Males, in the Time of Incubation; by Reaſon the Male, out of his conjugal Affection, almoſt ſtarves himſelf to ſupply the Female with Plenty.

tion. But of theſe Matters in a more proper Place (*x*).

2. When the young ones are produced, not only with what Care do they feed and nurſe them; but with what ſurpriſing Courage do all or moſt Creatures defend them! It is ſomewhat ſtrange to ſee timid Creatures (*y*), who at other Times are cowardly, to be full of Courage and undaunted at that Time; to ſee them furiouſly and boldly encounter their Enemy, inſtead of flying from him; and expoſe themſelves to every Danger, rather than hazard and forſake their Young.

With this earneſt Concern of the irrational Animals for their Young, we may join in the

V. And laſt Place, Their Faculty and Sagacity of feeding them. About which I ſhall take Notice of three Things:

1. The Faculty of ſuckling the Young, is an excellent Proviſion the Creator hath made for thoſe helpleſs Creatures. And here the Agreeableneſs and Suitableneſs of that Food to young Creatures, deſerves particular Obſervation; as alſo their Delight in it, and Deſire and Endeavours after it, even as ſoon as born (*z*), together with the Willingneſs of

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(*x*) See *Book* VII. *Chap.* iv.

(*y*) *Volucribus natura novam quandam, Pullos educandi, rationem excogitavit: ipſis enim præcipuum quendam amorem in ea quæ procrearent, ingeneravit, quo impulſu bellum pro pullis cum ferocibus animalibus, quæ ante declinârunt, intrepidè ſuſcipiunt, victûmque ipſis convenientem ſuppeditant.* Galen. de Uſ. Part. lib. xiv. cap. 4.

(*z*) *In iis animantibus quæ lacte aluntur, omnis ferè cibus matrum lacteſcere incipit: eaque, quæ paulo antè nata ſunt, ſine magiſtro, duce naturâ, mammas appetunt, earumque ubertate ſaturantur. Atque ut intelligamus nihil horum eſſe fortuitum, & hæc omnia eſſe provida, ſolertiſque naturæ, quæ multiplices fœtus procreant, ut Sues, ut Canes, his Mammarum data eſt multitudo; quas eaſdem paucas habent eæ beſtiæ, quæ pauca gignunt.* Cic. de Nat. Deor. lib. ii. cap. 51. *Conſule quoque* Galen de Uſ. Part. lib. xiv. cap. 4. & lib. xv. cap. 7.

all, even the moſt ſavage and fierce Animals, to part with it, and to adminiſter it to their Young, yea, to teach and inſtitute them in the Art of taking it.

And laſtly, to name no more, the curious *Apparatus* which is made for this Service in the divers Species of Animals, by a due Number of Breaſts, proportionable to the Occaſions of each Animal; by curious Glands in thoſe Breaſts, to ſeparate that nutritive Juice, the Milk, by Arteries and Veins to convey it to them, and proper Rivulets and Channels to convey it from them, with Dugs and Nipples, placed in the moſt convenient Part of the Body *(aa)* of each Animal, to adminiſter it to their Young; all theſe Things, I ſay, do manifeſtly proclaim the Care and Wiſdom of the great Creator.

2. As for ſuch Animals as do in another Manner breed up their Young, by finding out Food, and

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(aa) Animalia ſolidipeda, & ruminantia, vel cornigera, inter femora Mammas habent, quorum Fœtus ſtatim à partu pedibus inſiſtunt, quod matres inter lactandum non decumbant, ut Equa, Aſina, &c. Animalia digita & multipara in medio ventre, ſcilicet ſpatio ab inguine ad pectus (in cuniculo uſque ad jugulum) duplicem mammarum ſeriem ſortita ſunt, quæ omnia decumbentia ubera fœtibus admovent, ut Urſa, Leæna, &c. Si verò hæc in ſolo inguine Mammas gererent, propria cura inter decumbendum fœtûs acceſſum ad mammas nonnihil præpedirent. Mulieribus Mammæ binæ ſunt, ut & Papillæ, nimirum ut latus lateri conformitèr reſpondeat, & ut alternatim infans à latere in latus inter ſugendum transferatur, ne corpus ejus uni lateri nimis aſſueſcens quoque modo incurvetur. Simia, homo Sylveſtris, &c. Blaſ. Anat. Animal. part. i. cap. 6. *de Cane ex Whartono.* See here what *Pliny* hath alſo ſaid, lib. xi. cap. 40.

In the *Elephant*, the Nipples are near the Breaſt, by Reaſon the old one is forced to ſuck herſelf, and by the Help of her Trunk conveys the Milk into the Mouth of her Young. *Vide Phil. Tranſ.* N° 336.

putting it into their Mouth, the Proviſion made in them for this Service, to ſtrike, catch, to pouch and convey their Prey and Food to their Young *(bb)*, is very conſiderable. And ſo is alſo their Sagacity in equally diſtributing it among them, that among many, all ſhall be duly, equally, and in good Order, fed.

3. There is yet another Inſtinct remaining, of ſuch Animals as can neither adminiſter Suck to their Young, neither lay them in Places affording Food, nor can convey and bring them Food, but do with

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(bb) For an Exemplification, I might name many Animals, particularly Birds, whoſe Parts are completely ſuited to this Service. They are Characteriſtics of rapacious Birds, to have aduncous Bills and Talons, to hold and tear; and ſtrong brawny Thighs, to ſtrike and carry their Prey; as well as a ſharp piercing Sight, to ſpy it afar off. *Raii Synopſ. Method. Av.* p. i. The *Pelican* might alſo be here named, for its prodigious Bag under its Bill and Throat, big enough to contain thirty Pints. *Id. ibid.* p. 122. And, to name no more, the common *Heron* hath its moſt remarkable Parts, adapted to this Service; long Legs, for wading; and a long Neck, anſwerable thereto, to reach Prey; a wide extenſive Throat, to pouch it; long Toes, with ſtrong hooked Talons, (one of which is remarkably ſerrate on the Edge) the better to hold their Prey; a long ſharp Bill to ſtrike their Prey, and ſerrate towards the Point, with ſharp hooked Beards, ſtanding backward, to hold their Prey faſt when ſtruck; and laſtly, large, broad, concave Wings (in Appearance much too large, heavy and cumberſome for ſo ſmall a Body, but) of the greateſt Uſe to enable them to carry the greater Load to their Neſts, at ſeveral Miles Diſtance; as I have ſeen them do from ſeveral Miles beyond me, to a large Heronry above three Miles diſtant from me. In which I have ſeen *Plaiſe*, and other Fiſh, ſome Inches long, lying under the high Trees in which they build; and the curious and ingenious Owner thereof, *D'Acre Barret*, Eſq. hath ſeen a large *Eel* conveyed by them, notwithſtanding the great Annoyance it gave them in their Flight, by its twiſting this Way and that Way about their Bodies.

their Eggs, lay up Proviſions for their future Young. Somewhat of this is reported of ſome Birds *(cc)*; but I have myſelf, with Pleaſure, frequently ſeen ſome of the Species of Inſects to carry ample Proviſions into their dry and barren Cells, where they have ſealed them carefully and cautiouſly up with their Eggs, partly, it is like, for Incubation-ſake, and partly, as an eaſy Bed to lodge their Young; but chiefly, for future Proviſion for their Young, in their *Nympha-State*, when they ſtand in Need of Food *(dd)*.

(cc) This is reported of the *American Oſtrich*, mentioned by *Acarette* in *Philoſ. Tranſ.* N° 89, of which ſee *Book* VII. *Chap.* 4. *Note (e).*

(dd) Hornets, *Waſps*, and all the Kinds of *Bees* provide Honey; and many of the *Pſeudoſphecæ*, and *Ichneumon Waſps* and *Flies*, carry *Maggots*, *Spiders*, &c. into their Neſts; of which ſee above, *Chap.* xiii. *Note (c).*

CHAP. XVI.

The Concluſion.

THUS I have, as briefly as well I could, (and much more briefly than the Matters deſerved) diſpatched the Decad of Things I propoſed in common to the ſenſitive Creatures. And now let us pauſe a little, and reflect. And upon the whole Matter, what leſs can be concluded, than that there is a Being infinitely Wiſe, Potent, and Kind, who is able to contrive and make this glorious Scene of Things, which I have thus given only a Glance of? For what leſs than Infinite could Stock ſo vaſt a Globe with ſuch a noble Set of Animals? All ſo contrived, as to miniſter to one another's Help ſome

Way or other, and moſt of them ſerviceable to Man peculiarly, the Top of this lower World, and who was made, as it were, on Purpoſe to obſerve, and ſurvey, and ſet forth the Glory of the infinite *Creator*, manifeſted in his Works! Who! What, but the Great GOD, could ſo admirably provide for the whole Animal World, every Thing ſerviceable to it, or that can be wiſhed for, either to conſerve its Species, or to miniſter to the Being or Well-being of Individuals! Particularly, who could *Feed* ſo ſpacious a World, who could pleaſe ſo large a Number of Palates, or ſuit ſo many Palates to ſo great a Variety of Food, but the infinite Conſervator of the World! And who but the ſame Great HE, could provide ſuch commodious *Cloathing* for every Animal; ſuch proper *Houſes*, *Neſts*, and *Habitations*; ſuch ſuitable *Armature* and *Weapons*; ſuch *Subtilty*, *Artifice*, and *Sagacity*, as every Creature is more or leſs armed and furniſhed with, to fence off the Injuries of the Weather, to reſcue itſelf from Dangers, to preſerve itſelf from the Annoyances of its Enemies; and, in a Word, to conſerve itſelf, and its Species! What but an infinite ſuperintending Power could ſo equally *Balance* the ſeveral Species of Animals, and conſerve the *Numbers* of the Individuals of every Species ſo even, as not to Over or Under-People the Terraqueous Globe! Who, but the infinite-wiſe LORD of the World, could allot every Creature its moſt ſuitable *Place* to live in, the moſt ſuitable Element to *Breathe*, and *Move*, and *Act* in. And who but HE, could make ſo admirable a Set of Organs, as thoſe of Reſpiration are, both in Land and Water-Animals! Who could contrive ſo curious a Set of Limbs, Joints, Bones, Muſcles and Nerves, to give to every Animal the moſt commodious Motion to its State and Occaſions! And, to name no more, What Anatomiſt, Mathematician, Workman, yea, Angel, could contrive and make ſo curious, ſo commodious, and every Way ſo exquiſite a Set of Senſes, as the *five Senſes* of Animals are! whoſe Organs are ſo dexterouſly contrived, ſo conveniently placed in the Body, ſo neatly adjuſted, ſo firmly guarded, and ſo completely ſuited to every Occaſion, that they plainly ſet forth the Agency of the infinite Creator and Conſervator of the World.

So that here, upon a tranſient View of the Animal World in General only, we have ſuch a Throng of Glories, ſuch an enraviſhing Scene of Things, as may excite us to Admire, Praiſe, and Adore the infinitely Wiſe, Powerful, and Kind CREATOR; to condemn all Atheiſtical Principles; and with Holy *David*, *Pſal.* xiv. 1. to conclude, That he is in good Earneſt a *Fool*, that dares to ſay, *There is no GOD*, when we are every where ſurrounded with ſuch manifeſt Characters, and plain Demonſtrations of that Infinite Being.

But in the next BOOK we ſhall ſtill find greater Tokens, if poſſible, when I come to take a View of Animals in Particular.

A SURVEY OF THE PARTICULAR TRIBES of ANIMALS.

IN the foregoing Book, having taken a View of the Things in common to Animals, my Buſineſs in the next, will be to inſpect the particular Tribes, in order to give further Manifeſtations of the Infinite Creator's Wiſdom, Power, and Goodneſs towards the Animal World.

BOOK V.

A SURVEY of MAN.

THE firſt *Genus* of Animals that I ſhall take Notice of, ſhall be MAN, who may juſtly claim the Precedence in our Diſcourſe, inaſmuch as GOD hath given him the Superiority in the Animal World, *Gen.* i. 26. *And God ſaid, Let us make Man in our Image, after our*

our Likeneſs; and let them have Dominion over the Fiſh of the Sea, and over the Fowl of the Air, and over the Cattle, and over all the Earth, and over every creeping Thing that creepeth upon the Earth.

And as to Man, we have ſo excellent a Piece of Workmanſhip, ſuch a Microcoſm, ſuch an Abridgment of the Creator's Art in him, as is alone ſufficient to demonſtrate the Being and Attributes of GOD. Which will appear, by conſidering the *Soul* and the *Body*, of Man.

CHAP. I.

Of the Soul of Man.

MY Survey of Man, I ſhall begin with the Soul of Man, by reaſon it is his moſt Noble Part *(a)*, the Copy of the Divine Image in us *(b)*, in which we have enough to fill us with Admiration of the Munificence, Power, and Wiſdom of the

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(a) Jam verò Animum ipſum, Mentemque hominis, Rationem, Conſilium, Prudentiam, qui non divinâ curâ perfecta eſſe perſpicit, is his ipſis rebus mihi videtur carere. Cic. de Nat. Deor. lib. ii. cap. 59.

(b) Senſum à Cæleſti demiſſum traximus arce,
Cujus egent prona, & terram ſpectantia: mundi
Principio indulſit communis Conditor, illis
Tantùm Animas; nobis Animum quoque.
Juven. Sat. xv. V. 144.

Et cùm non aliter poſſent mortalia fingi.
Adjunxit geminas, illæ cum corpore lapſæ
Intereunt: hæc ſola manet, buſtoque ſuperſtes
Evolat.
Claud. de 4 Conſul. Hon.

Infinite Creator (*c*), when we contemplate the noble Faculties of this our ſuperior Part, the vaſt Reach and Compaſs of its *Underſtanding*, the prodigious Quickneſs and Piercingneſs of its *Thought*, the admirable Subtilty of its *Invention*, the commanding Power of its *Wiſdom*, the great Depth of its *Memory* (*d*), and in a Word, its *Divine Nature* and *Operations*.

But I ſhall not dwell on this, though the ſuperior Part of Man, becauſe it is the leaſt known. Only there are two Things I cannot eaſily paſs by, be-

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(*c*) *Nam ſiquis nulli ſectæ addictus, ſed liberâ ſententiâ verum conſiderationem inierit, conſpicatus in tantâ carnium ac ſuccorum colluvie tantam mentem habitare; conſpicatus item & cujuſvis animalis conſtructionem (omnia enim declarant Opificis Sapientiam) Mentis, quæ homini ineſt, excellentiam intelliget, tum opus de partium utilitate, quod prius exiguum eſſe ſibi videbatur, perfectiſſimæ Theologiæ verum principium conſtituet: quæ Theologia multò eſt major atque præſtantior totâ Medicinâ.* Galen de Uſ. Part. lib. xvii. cap. 1.

(*d*) Among many Examples that I could give of Perſons famous for *Memory*, *Seneca*'s Account of himſelf may be one: *Hanc* [*Memoriam*] *aliquando in me floruiſſe, ut non tantûm ad uſum ſufficeret, ſed in miraculum uſque procederet, non nego. Nam &* 2000 *nominum recitata, quo ordine erant dicta, reddebam: & ab his qui ad audiendum præceptorem noſtrum convenerunt, ſingulos verſus à ſingulis datos, cùm plures quàm* 200 *efficerentur; ab ultimo incipiens uſque ad primum recitabam.* After which, mention is made of the great Memory of *Latro Porcius*, (*chariſſimi mihi ſodalis*, *Seneca* calls him) who retained in his Memory all the Declamations he had ever ſpoken, and never had his Memory fail him, not ſo much as in one ſingle Word. Alſo, he takes Notice of *Cyneas*, Ambaſſador to the *Romans*, from King *Pyrrhus*, who in one Day had ſo well learned the Names of his Spectators, that *poſtero die novus homo & Senatum, & omnem urbanam circumfuſam Senatui plebem, nominibus ſuis perſalutavit.* Senec. Controverſ. lib. i. init. Vid. quoque Plin. lib. vii. cap. 24. where he alſo adds other Examples, *viz. Cyrus rex omnibus in exercitu ſuo militibus nomina reddidit; L. Scipio populo Rom. Mithridates* 22 *gentium rex, totidem linguis jura dedit, pro concione ſingulas ſine interprete affatus. Charmidas (ſeu potius Carneades) — quæ quis exegerat volumina in bibliothecis, legentis modo repræſentavit.*

cauſe they manifeſt the eſpecial Concurrence and Deſign of the infinitely wiſe Creator, as having a particular and neceſſary Tendency to the Management and good Order of the World's Affair. The

Iſt. Of which is the various *Genii*, or *Inclinations of Men's Minds* to this, and that, and the other Buſineſs (*e*). We ſee how naturally Men betake themſelves to this and that Employment: Some delight moſt in Learning and Books, ſome in Divinity, ſome in Phyſic, Anatomy, and Botany, ſome in Critical Learning, and Philology, ſome in Mathematicks, ſome in Metaphyſicks, and deep Reſearches; and ſome have their Delight chiefly in Mechanicks, Architecture, War, Navigation, Commerce, Agriculture; and ſome have their Inclinations lie even to the ſervile Offices of the World, and an hundred Things beſides.

Now all this is an admirably wiſe, as well as moſt neceſſary Proviſion, for the eaſy and ſure tranſacting the World's Affairs; to anſwer every End and Occaſion of Man, yea, to make Man helpful to the poor helpleſs Beaſts, as far as his Help is needful to them; and all, without any great Trouble, Fatigue, or great Inconvenience to Man; rather as a

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(*e*) *Diverſis etenim gaudet natura miniſtris,*
Ut fieri diverſa queant ornantia terras.
Nec patitur cunctos ad eandem currere metam,
Sed varias jubet ire vias, varioſque labores
Suſcipere, ut variò cultu ſit pulchrior orbis.
Paling. in Scorp.

Οὕτως οὐ πάντεσσι Θεὸς χαρίεντα δίδωσι
Ἀνδράσιν, &c.

Ita non omnibus hominibus ſua dona dat Deus, neque bonam indolem, neque prudentiam, nec eloquentiam: alius namque vultum habet deformem; ſed Deus formam eloquentiâ ornat, &c. Hom. Odyſ. 8. The like alſo in *Iliad.* lib. xiii.

Pleaſure and Diverſion to him. For ſo far it is from being a Toil, that the greateſt Labours (*f*), Cares, yea, and Dangers too, become pleaſant to him who is purſuing his *Genius*, and whoſe Ardour of Inclination eggs him forward, and buoys him up under all Oppoſition, and carrieth him through every Obſtacle, to the End of his Deſigns and Deſires.

II. The next is, The *inventive* Power of the Soul (*g*). Under which I might ſpeak of many Things; but I ſhall take Notice only of Two, becauſe they manifeſt the particular Concern and Agency of the infinitely wiſe Creator. The

1. Is, That *Man's Invention* ſhould reach to ſuch a great Variety of Matters; that it ſhould hit upon every thing that may be of any Uſe, either to himſelf, or to human Society, or that may any ways promote (what in him lies), the Benefit of this lower Part of the Creation.

For the Illuſtration of this, I might take a View of all the Arts and Sciences, the Trades, yea, the very Tools they perform their Labours and Contrivances with, as numerous as their Occaſions and Contrivances are various. Indeed, What is there that falleth under the Reach of Man's Senſes, that

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(*f*) Although *Solomon* declares, *Eccleſ.* xii. 12. *That much Study is a Wearineſs to the Fleſh*; yet we ſee with what Pleaſure and Aſſiduity many apply themſelves to it. Thus *Cicero* tells of *Cato*, whom he caſually found in *Lucullus*'s Library; *M. Catonem vidi in Bibliothecâ ſedentem, multis circumfuſum Stoicorum libris. Erat enim, ut ſcis, in eo inexhauſta aviditas legendi, nec ſatiari poterat: quippe ne reprehenſionem quidem vulgi inanem reformidans, in ipſâ curiâ ſoleret legere ſæpe, dum ſenatus cogeretur — ut Heluo librorum — videbatur.* Cicer. de Finib. lib. iii. cap. 2.

(*g*) *Mentem hominis, quamvis eam non videas, ut Deum non vides, tamen ut Deum agnoſcis ex operibus ejus, ſic ex memoriâ rerum, & Inventione, & celeritate motûs, omnique pulchritudine virtutis vim divinam mentis agnoſcito.* Cicer. Tuſc. Quæſt. lib. i. cap. 29.

he doth not employ to ſome Uſe and Purpoſe, for the World's Good? The celeſtial Bodies, the Sun, the Moon, with the other Planets, and the fixed Stars, he employs to the noble Uſes of Aſtronomy, Navigation, and Geography. And, what a noble Acumen, what a vaſt Reach muſt the Soul be endowed with, to invent thoſe curious Sciences of Geometry and Arithmetick, both Specious, and in Numbers; and thoſe nice and various Inſtruments, made uſe of by the Geometrican, Aſtronomer, Geographer and Sailor? And, laſtly, what a wonderful Sagacity is ſhewn in the Buſineſs of Opticks and particularly in the late Invention of the Teleſcope; wherewith new Wonders are diſcovered among God's Works, in the Heavens, as there are here on Earth, with the Microſcope, and other Glaſſes.

And as for this lower World, what Material is there to be found; what kind of Earth, or Stone, or Metal; what Animal, Tree, or Plant, yea even the very Shrubs of the Field; in a Word, what of all the excellent Variety, the Creator has furniſhed the World with, for all its Uſes and Occaſions, in all Ages; what, I ſay, that Man's Contrivance doth not extend unto, and make ſome Way or other advantageous to himſelf, and uſeful for Building, Cloathing, Food, Phyſick, or for Tools or Utenſils, or for even only Pleaſure and Diverſion?

But now conſidering the great Power and Extent of human Invention,

2. There is another Thing, that doth farther demonſtrate the Super-intendence of the great Creator and Conſervator of the World; and that is, That Things of great, and abſolutely neceſſary Uſe, have ſoon, and eaſily occurred to the Invention of Man; but Things of little Uſe, or very dangerous Uſe, are rarely and ſlowly diſcovered, or ſtill utterly undiſcovered. We have as early as the *Moſaick* Hiſtory, an Account of the Inventions of the more

uſeful Crafts and Occupations: Thus *Gen.* iii. 23. Adam *was ſent forth from the Garden of* Eden, *by God himſelf, to till the Ground.* And in the next Chapter, his two Sons *Cain* and *Abel*; the one was of the ſame Occupation, a Tiller of the Ground, the other a Keeper of Sheep *(h)*. And the Poſterity of theſe, are in the latter End of *Gen.* iv. recorded, Jabal, *to have been the Father of ſuch as dwell in Tents (i)*; *i. e.* He was the *Inventor of Tents*, and pitching thoſe moveable Houſes in the Fields, for looking after, and depaſturing their Cattle in the Deſerts, and uncultivated World. Tubal-Cain *was an Inſtructor of every Artificer in Braſs and Iron (k)*, or the Firſt that found out the Art of *melting and malleating (l) Metals*, and making them uſeful for Tools, and other neceſſary Implements. And his Siſter *Naamah*, whoſe Name is only mentioned, is by ſome thought to have been the Inventor of *Spinning* and *Cloathing*. Yea, the very Art of *Muſick* is thus early aſcribed to *Jubal (m)*; ſo indulgent was the Creator, to find a Means to divert Melancholy, to cheer the Spirits, and to entertain and pleaſe Mankind. But for Things of no Uſe, or but little Uſe, or of pernicious Conſequence, either they have been much later thought of, and with great Difficulty, and perhaps Danger too, brought to paſs, or elſe they ſtill are, and perhaps will always remain Exerciſes of the Wit and Invention of Men.

Of this we might give divers Inſtances: In Mathematicks, about ſquaring the Circle *(n)*; in Mechanicks

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(h) Gen. iv. 2.

(i) Ver. 20.

(k) Ver. 22.

(l) Σφυροκόπος, the LXX call him, *i. e.* A Worker with an Hammer.

(m) Ver. 21.

(n) Although the *Quadrature of the Circle*, hath in former Ages

chanicks (o), about the Art of Flying: and in Navigation, about finding the Longitude. Theſe Things, although ſome of them in Appearance innocent, yea, perhaps very uſeful, yet remain for the moſt Part ſecret; not becauſe the Diſcovery of

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Ages exerciſed ſome of the greateſt mathematical Wits; yet nothing has been done in that Way ſo conſiderable, as in and ſince the Middle of the laſt Century; when in the Year 1657, thoſe very ingenious and great Men, Mr. *William Neile*, and my Lord *Brounker*, and Sir *Chriſtopher Wren* afterwards, in the ſame Year, geometrically demonſtrated the Equality of ſome Curves to a ſtrait Line. Soon after which, others at Home, and Abroad, did the like in other Curves. And not long afterwards, this was brought under an *analytical Calculus*: The firſt Specimen whereof, that was ever publiſhed, Mr. *Mercator* gave in 1688, in a Demonſtration of my Lord *Brounker's* Quadrature of the *Hyperbola*, by Dr. *Wallis's* Reduction of a Fraction into an infinite Series, by Diviſion. But the penetrating Genius of Sir *Iſaac Newton*, had diſcovered a Way of attaining the Quantity of all quadrible Curves analytically, by his Method of *Fluxions*, ſome Time before the Year 1668, as I find very probable from an hiſtorical Account, in a long Letter of Mr. *Collins*, written in his own Hand, and ſent to *Richard Townley*, Eſq. of *Lancaſhire*, whoſe Papers are in my Hands. In that Letter, Mr. *Collins* ſaith, That *in* September 1698, *Mr.* Mercator *publiſhed his* Logarithmotechnia, *one of which he ſoon ſent to Dr.* Barrow, *who thereupon ſent him up ſome Papers of Mr.* Newton's [now Sir *Iſaac*;] *by which, and former Communications made thereof by the Author, to the Doctor, it appears, that the ſaid Method was invented ſome Years before by the ſaid Mr.* Newton, *and generally applied.* And then he goes on to give ſome Account of the Method: what it performs in the Circle, *&c.* what Mr. *Gregory* had done in that kind, *who intended to publiſh ſomewhat in* Latin *about it, but would not anticipate Mr.* Newton, *the firſt Inventor thereof*; with much more of this Nature. The Deſign, I find, of that indefatigable Promoter of Mathematicks, Mr. *Collins*, was to acquaint Mr. *Townley*, in his Letter, with what had been done; and to get the Aſſiſtance of that ingenious Gentleman, towards the completing a Body of *Algebra*.

(o) I do not mention here the *perpetual Motion*, which hath exerciſed the Mechanical Wits for many Ages; becauſe it is a Thing impoſſible, if not a Contradiction: As the before commended Dr. *Clarke* aſſerts in *Rohaul. Phyſ.* p. 133.

moſt of them is more impoſſible, or difficult than of many other Things, which have met with a Diſcovery; nor is it for want of Man's Diligence therein, or his careful Purſuit and Enquiry after them, (for, perhaps, nothing already diſcovered hath been more eagerly ſought after;) but with much better Reaſon, (I am ſure with greater Humility and Modeſty,) we may conclude it is, becauſe the infinitely wiſe Creator, and Ruler of the World, hath been pleaſed to lock up theſe Things from Man's Underſtanding and Invention, for ſome Reaſons beſt known to himſelf, or becauſe they might be of ill Conſequence, and dangerous amongſt Men.

As in all Probability the Art of Flying would particularly be: An Art which in ſome Caſes might be of good Uſe, as to the Geographer and Philoſopher; but in other Reſpects, might prove of dangerous and fatal Conſequence: As for Inſtance, By putting it in Man's Power to diſcover the Secrets of Nations and Families more than is conſiſtent with the Peace of the World, for Man to know; by giving ill Men greater Opportunities to do Miſchief, which it would not lie in the Power of others to prevent; and, as one (*p*) obſerves, by making Men leſs ſociable: "For upon every true or falſe "Ground of Fear, or Diſcontent, and other Occa"ſions, he would have been fluttering away to "ſome other Place; and Mankind, inſtead of co"habiting in Cities, would, like the Eagle, have "built their Neſts upon Rocks."

That this is the true Reaſon of theſe Matters, is manifeſt enough from Holy Scripture; and Reaſon (*q*) alſo gives its Suffrage thereto. The *Scripture* expreſly tells us, That *every good Gift, and every*

(*p*) Grew's *Coſmol. Sacr.* lib. i. cap. 5. *ſect.* 25.

(*q*) *Nemo igitur vir magnus ſine aliquo afflatu divino unquam fuit.* Cic. de Nat. Deor. lib. ii. cap. 66.

perfect Gift, is from above, and cometh down from the Father of Lights, St. James i. 17. *Solomon*, Prov. ii. 6. ſaith, *The Lord giveth Wiſdom; out of his Mouth cometh Knowledge and Underſtanding.* And *Elihu* is very expreſs, *Job* xxxii. 8. *But there is a Spirit in Man, and the Inſpiration of the Almighty giveth them Underſtanding*, Πνοὴ παντοκράτορός ἐστιν ἡ διδάσκουσα, as the LXX render it, *The Inſpiratus, the Afflatus of the Almighty, is their Inſtructor, Miſtreſs, or Teacher.* And in Scripture, not only the more noble, ſuperior Acts of Wiſdom or Science, but much inferior alſo, bear the Name of Wiſdom, Knowledge, and Underſtanding, and are aſcribed unto GOD. It is well known that *Solomon*'s Wiſdom is wholly aſcribed unto GOD; and the Wiſdom and Underſtanding which GOD is ſaid to have given him, 1 *Kings* iv. 29. is particularly ſet forth in the following Verſes, by his great Skill in moral and natural Philoſophy, in Poetry, and probably in Aſtronomy, Geometry, and ſuch other of the politer Sciences, for which *Ægypt*, and the *Eaſtern Nations* were celebrated of Old (r): *And* Solomon's *Wiſdom excelled the Wiſdom of all the Children of the Eaſt Country, and all the Wiſdom of* Ægypt. *For he was wiſer than all Men, than* Ethan, *&c. And he ſpake* 3000 *Proverbs: And his Songs were* 1005. *And he ſpake of Trees, from the Cedar to the Hyſſop of the Wall,* (i. e. of all Sorts of Plants;) *alſo of Beaſts, Fowl, creeping Things, and Fiſhes.* So likewiſe the Wiſdom of *Daniel*, and his three Companions, is aſcribed unto GOD, *Dan.* i. 17. *As for theſe four*

(r) *Ægypt*, and ſome of the *Eaſtern* Nations, are celebrated for their Skill in polite Literature; both in the Scripture and profane Story: *Job* was of thoſe Parts; ſo were the Σοφοὶ and Μάγοι, the *Brachmans* and *Gymnoſophiſts*. *Moſes* and *Daniel* had their Education in theſe Parts; And *Pythagoras, Democritus*, and others, travelled into theſe Parts, for the Sake of their Learning.

Children God gave them Knowledge, and Skill in all Learning and Wiſdom; *and* Daniel *had Underſtanding in all Viſions and Dreams.* And accordingly in the next Chapter, *Daniel* acknowledgeth and praiſeth God, *ver.* 20, 21. Daniel *anſwered and ſaid, Bleſſed be the Name of God for ever and ever, for Wiſdom and Might are his, —— He giveth Wiſdom unto the Wiſe, and Knowledge to them that know Underſtanding.* But not only Skill in ſuperior Arts and Sciences, but even in the more inferior mechanick Art, is called by the ſame Names, and aſcribed unto GOD: Thus for the Workmanſhip of the Tabernacle, *Exod.* xxxi. 2. to *ver.* 6. *See, I have called* Bezaleel; *and I have filled him with the Spirit of God, in Wiſdom, and in Underſtanding, and in all Manner of Workmanſhip: To deviſe cunning Works to to work in Gold, Silver, and Braſs*; *and in cutting of Stones, to ſet them*; *and in carving of Timber, to work in all Manner of Workmanſhip.* So the *Spinſters, Weavers,* and other Crafts-people, are called wiſe-hearted, *Exod.* xxxiv. 10, 25, and other Places. And in *Exod.* xxxvi. 1, &c. the LORD is ſaid to have put this Wiſdom in them, and Underſtanding to know how to work all theſe Manner of Works, for the Service of the Sanctuary. And laſtly, to name no more Inſtances, *Hiram* the chief Architect of *Solomon*'s Temple, is in 1 *Kings* vii. 14 and 2 *Chron.* ii. 14. called *a cunning Man, filled with Wiſdom and Underſtanding, to work in Gold, Silver, Braſs, Iron, Stone, Timber, Purple, Blue, fine Linen, and Crimſon*; *alſo to grave, and find out every Device which ſhould be put to him.*

Thus doth the Word of *God* aſcribe the Contrivances and Crafts of Men, to the Agency, or Influence of the *Spirit of God,* upon that of Man. And there is the ſame Reaſon for the Variety of *Genii,* or *Inclinations* of Men alſo; which from the ſame Scriptures may be concluded to be a Deſignation, and Tranſaction of the ſame Almighty Governor of the World's Affairs. And who indeed but HE, could make ſuch a divine Subſtance endowed with thoſe admirable Faculties and Powers, as the rational Soul hath; a Being to bear the great Creator's Vicegerency in this Lower World; to employ the ſeveral Creatures; to make Uſe of the Various Materials; to manage the Grand Buſineſſes; and to ſurvey the Glories of all the viſible Works of God? A Creature, without which this lower World would have been a dull, uncouth, and deſolate kind of Globe. Who, I ſay, or what leſs than the *Infinite GOD*, could make ſuch a rational Creature, ſuch a divine Subſtance as the Soul! For if we ſhould allow the Atheiſt any of his nonſenſical Schemes, the *Epicurean* his fortuitous Concourſe of Atoms, or the *Carteſian (s)* his created Matter put in Motion; yet with what tolerable Senſe could he, in his Way, produce ſuch a divine, thinking, ſpeaking, contriving Subſtance as the Soul is; endowed exactly with ſuch Faculties, Power, and Diſpoſitions as the various Neceſſities and Occaſions of the World require from ſuch a Creature? Why ſhould not rather all the Acts, the Diſpoſitions and Contrivances of ſuch a Cretaure as

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(s) As we are not to *accuſe* any *falſly*, ſo far be it from me to detract from ſo great a Man as Monſieur *Cartes* was; whoſe Principles, although many have preverted to atheiſtical Purpoſes, and whoſe Notions have, ſome of them, but an ill Aſpect, yet I am unwilling to believe he was an Atheiſt; ſince in his *Principia Philoſophiæ*, and other of his Works, he vindicates himſelf from this Charge; and frequently ſhews ſeemingly a great Reſpect for Religion; Beſides that, many of his ſuſpicious Opinions are capable of a favourable Interpretation, which will make them appear in a better Form: Thus when he diſcardeth *final Cauſes* from his Philoſophy, it is not a Denial of them; but only excluding the Conſideration of them, for the Sake of free philoſophiſing; it being the Buſineſs of a Divine, rather than a Philoſopher, to treat of them.

Man, if made in a mechanical Way, and not contrived by God, have been the ſame? Particularly, Why ſhould he not have hit upon all Contrivances of equal Uſe, early, as well as many Ages ſince? Why not that Man have effected, as well as this ſome thouſands of Years after? Why alſo ſhould not all Nations, and all Ages (*t*), improve

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(*t*) For Ages of *Learning* and *Ignorance*, we may compare the preſent and ſome of the Ages before the Reformation. The laſt Century, and the few Years of this, have had the Happineſs to be able to vie with any Age for the Number of learned Men of all Profeſſions, and the Improvement made in all Arts and Sciences; too many, and too well known to need a Specification.

But for Ignorance, we may take the ninth Age, and ſo down to the Reformation; even as low as Queen *Elizabeth*, although Learning began to flouriſh; yet we may gueſs how Matters ſtood, even among the Clergy, by her 53 *Injunct.* N° 1559. *Such as are but mean Readers, ſhould peruſe over before, once or twice, the Chapters and Homilies, to the Intent they may read to the better Underſtanding of the People, the more Encouragement of Godlineſs.* Spar. Collect. p. 82. But this is nothing, in compariſon to the Ages before, when the Monk ſaid, *Græcam non eſt legi*; or as *Eſpencæus* more elegantly hath it, *Græcè nôſſe ſuſpectum, Hebraicè prope Hæreticum.* Which Suſpicion, (ſaid the learned *Hakewill,*) *Rhemigius*, ſurely was not guilty of, in commenting upon *diffamatus*, 1 *Theſ.* i. 8. who ſaith, that St. *Paul* ſomewhat improperly put that for *divulgatus*, not being aware that St. *Paul* wrote in *Greek*, and not in *Latin*. Nay, ſo great was their Ignorance, not only of *Greek*, but of *Latin* too, that a Prieſt baptized *in nomine Patria, & Filia, Spiritua ſancta.* Another ſuing his Pariſhoners for not paving his Church, proved it from *Jer.* xvii. 18. *Paveant illi, non paveam ego.* Some Divines in *Eraſmus*'s Time, undertook to prove Hereticks ought to be burnt, becauſe the Apoſtle ſaid, *Hæreticum devita.* Two Fryars diſputing about a Plurality of Worlds, one proved it from *Annon decem ſunt facti mundi?* The other replyed, *Sed ubi ſunt novem?* And notwithſtanding their Service was read in *Latin*, yet ſo little was that underſtood, that an old Prieſt in *Hen.* VIII's time, read *Mumpſimus Domine* for *Sumpſimus*: And being admoniſhed of it, he ſaid, he had done ſo for thirty Years, and would not leave his old *Mumpſimus* for their new *Sumpſimus.* Vid. *Hakew. Apol.* lib. 3. chap. 7. *ſect.* 2.

in every Thing, as well as this, or that Age, or Nation (*u*) only? Why ſhould the *Greeks*, the *Arabians*, the *Perſians*, or the *Egyptians* of old, ſo far exceed thoſe of the ſame Nations now? Why the *Africans* and *Americans* ſo generally ignorant and barbarous, and the *Europeans*, for the moſt part, polite and cultivated, addicted to Arts and Learning? How could it come to paſs, that the

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(*u*) *There is (it ſeems) in Wits and Arts, as in all Things beſide, a kind of circular Progreſs: They have their Birth, their Growth, their Flouriſhing, their Failing, their Fading; and within a while after, their Reſurrection, and Reflouriſhing again. The Arts flouriſhed for a long Time among the* Perſians, *the* Chaldæns, *the* Egyptians — *But afterwards the* Grecians *got the Start of them*, and are now become as barbarous themſelves, as formerly they eſteemed all beſides themſelves to be. About the Birth of *Chriſt*, Learning began to flouriſh in *Italy*, and ſpread all over *Chriſtendom*, till the *Goths*, *Huns*, and *Vandals*, ranſacked the Libraries, and defaced almoſt all the Monuments of Antiquity: So that the Lamp of Learning ſeemed to be put out, for near the Space of 1000 Years, till the firſt *Manſor*, King of *Africa* and *Spain*, raiſed up, and ſpurred forward the *Arabian* Wits, by great Rewards and Encouragements. Afterwards *Petrarch* opened ſuch Libraries as were undemoliſhed. He was ſeconded by *Boccace*, and *John* of *Ravenna*, and ſoon after by *Aretine*, *Philelphus*, *Valla*, &c. And thoſe were followed by *Æneas Sylvius*, *Angelus Politianus*, *Hermolaus Barbarus*, *Marſilius Ficinus*, and *Joh. Picus* of *Mirandula*. Theſe were backed by *Rud. Agricola*, *Reucline*, *Melancthon*, *Joach. Camerarius*, *Wolphlazius*, *Beat. Rhenanus*, Almaines: By *Eraſmus* of *Rotterdam*; *Vives*, a *Spaniard*; *Bembus*, *Sadoletus*, *Eugubinus*, Italians: *Turnebus*, *Muretus*, *Ramus*, *Pithæus*, *Budæus*, *Amiot*, *Scaliger*, Frenchmen; Sir *Tho. More*, and *Linaker*, Engliſhmen. And about this Time, even thoſe Northern Nations yielded their great Men; *Denmark* yielded *Olaus Magnus*, *Holſter*, *Tycho Brahe*, and *Hemingius*; and *Poland*, *Hoſius*, *Frixius*, and *Crumerus*. But to name the Worthies that followed theſe, down to the preſent Time, would be endleſs, and next to impoſſible. See therefore *Hakewill's Apolog.* lib. iii. cap. 6. ſect. 2.

Uſe of the Magnet *(w)*, Printing *(x)*, Clocks *(y)*, Teleſcopes,

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(w) Dr. *Gilbert*, the moſt learned and accurate Writer on the *Magnet*, ſhews, That its *Attractive* Virtue was known as early as *Plato* and *Ariſtotle*; but its *Direction* was a Diſcovery of later Ages. He ſaith, *Superiori ævo* 300 *aut* 400 *labentibus annis, Motus Magneticus in Boream & Auſtrum repertus, aut ab hominibus rurſus recognitus fuit.* De Mag. lib. i. cap. 1. But who the happy Inventer of this lucky Diſcovery was, is not known. There is ſome, not inconſiderable, Reaſon, to think, our famous Countryman, *Rog. Bacon*, either diſcovered, or at leaſt knew of it. But for its Uſe in Navigation, Dr. *Gilbert* ſaith, *In regno Neapolitano Melphitani omnium primi (uti fuerunt) pyxidem inſtruebant nauticam—edocti à cive quodam Jol. Goia*, A. D. 1300. ibid. If the Reader hath a mind to ſee the Arguments for the Invention, being as old as *Solomon*'s or *Plautus*'s Time, or of much younger Date, he may conſult *Hakewill*, lib. cap. x. ſect. 4. or *Purchas Pilgr.* lib. 1 cap. 1. ſect. 1.

As to the Magnetick Variation, Dr. *Gilbert* attributes the Diſcovery of it to *Sebaſtian Cabott*. And the Inclination, of Dipping of the Needle was the Diſcovery of our ingenious *Rob. Norman*. And laſtly, The Variation of the Variation; was firſt found out by the ingenious Mr. *H. Gellibrand*. Aſtr. Prof. of *Greſh. Coll.* about 1634. *Vide Gellibr. Diſc. Math. on the Variation of the Mag. Needle, and its Variat.* Anno 1635.

But ſince that, the before commended Dr. *Halley*, having formerly, in *Philoſ. Tranſ.* N° 148, and 195, given a probable Hypotheſis of the Variation of the Compaſs, did, in the Year 1700, undertake a long and hazardous Voyage, as far as the Ice near the South Pole, in order to examine his ſaid Hypotheſis, and to make a Syſtem of the Magnetical Variations: Which being ſoon after publiſhed, has been ſince abundantly confirmed by the *French*, as may be ſeen in ſeveral of the late *Memoires de Phyſique & de Mathematique*, publiſhed by the *French Academie des Sciences*.

To theſe Diſcoveries, I hope the Reader will excuſe me, if I add one of my own, which I deduced ſome Years ago, from ſome Magnetical Experiments and Obſervations I made; which Diſcovery I alſo acquainted our Royal Society with, ſome Time ſince, *viz.* That as the common, horizontal Needle is continually varying up and down, towards the E. and W. ſo is the Dipping-Needle varying up and down, towards or fromwards the Zenith, with its Magnetick Tendency, deſcrib-

Teleſcopes (z), and an hundred Things beſides, ſhould eſcape the Diſcovery of *Archimedes*, *Anaximander*,

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deſcribing a Circle round the Pole of the World, as I conceive, or ſome other Point. So that if we could procure a Needle ſo nicely made, as to point exactly according to its Magnetick Direction, it would, in ſome certain Number of Years, deſcribe a Circle, of about 13 *gr.* Radius round the Magnetick Poles Northerly and Southerly. This I have for ſeveral Years ſuſpected, and have had ſome Reaſon for it too, which I mentioned three or four Years ago, at a Meeting of our *Royal Society*; but I have not yet been ſo happy to procure a tolerable good Dipping-Needle, or other proper one to my Mind, to bring the Thing to ſufficient Teſt of Experience, as in a ſhort Time I hope to do, having lately hit upon a Contrivance that may do the Thing.

(x) It is uncertain who was the Inventer of the Art of *Printing*, every Hiſtorian aſcribing the Honour thereof to his own City or Country. Accordingly, ſome aſcribe the Invention of it to *John Guttenburg*, a Knight of *Argentine*, about 1440, and ſay, that *Fauſtus* was only his Aſſiſtant. *Bertius* aſcribes it to *Laurence John*, of *Haerlem*, and ſaith, *Fuſt* or *Fauſt*, ſtole from him both his Art and Tools. And, to name no more, ſome attribute it to *John Fuſt* or *Fauſt*, and *Peter Schoeffer*, (called by *Fuſt*, in ſome of his *Imprimaturs*, *Pet. de Gernſhem puer meus.*) But there is now to be ſeen at *Haerlem*, a Book or two printed by *Lau. Koſter*, before any of theſe; *viz.* in 1430, and in 1432. (*See Mr.* Ellis'*s Letter to Dr.* Tyſon, *in Phil. Tranſ.* N° 286.) But be the firſt Inventer who it will, there is however great Reaſon to believe the Art received great Improvements from *Fauſt*, and his Son-in-Law *Schoeffer*, the Latter being the Inventer of metalline Types, which were cut in Wood before, firſt in whole Blocks, and afterwards in ſingle Types or Letters. See my learned Friend Mr. *Wanley*'s Obſervations in *Philoſ. Tranſ.* N° 288, and 310.

(y) Concerning the Antiquity and Invention of *Clocks* and *Clock-Work*, I refer the Reader to a little Book, called, *The Artificial Clock-Maker*, Chap. 6. where there is ſome Account of the Antients Inventions in Clock-Work, as *Archimedes*'s *Sphere*, *Creſibius*'s *Clock*, &c.

(z) The Invention of *Teleſcopes*, *Hieron. Syrturus* gives this Account of, *Prodiit* Anno 1609, *ſeu Genius, ſeu alter vir adhuc incognitus. Hollandi ſpecie, qui Middleburgi in Zelandiâ convenit Joh. Lipperſein — Juſſit perſpicilla plura tam cava quam con-*

mander, *Anaximenes*, *Poſidonius*, or other great Virtuoſos of the early Ages, whoſe Contrivances of various Engines, Spheres, Clepſydræ, and other curious Inſtruments, are recorded *(aa)*? And why cannot

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vexa, confici. Condictio die rediit, abſolutum opus cupiens, atque ut ſtatim habuit præ manibus, bina ſuſcipiens, cavum ſcil. & covexum, unum & alterum oculo admovebat, & ſenſim dimovebat ſive ut punctum concurſûs, ſive ut artificis opus probaret, poſtea abiit. Artifex, ingenii minimè expers, & novitatis curioſus cœpit idem facere & imitari, &c. Vid. Muſ. Worm. lib. iv. cap. 7.

(aa) Among the curious Inventions of the Antients, *Archytas*'s *Dove* was much famed; of which *Aul. Gellius* gives this Account: *Scripſerunt Simulachrum Columbæ è ligno ab Archytâ ratione quadam diſciplinâque mechanicâ factum, volâſſe: Ita erat ſcilicet libramentis ſuſpenſum, & aurâ ſpiritûs incluſâ atque occultâ concitum.* Noct. Attic. lib. x. cap. 12. The ſame eminent *Pythagorean* Philoſopher (as *Favorinus* in *Gellius* calls him) is by *Horace* accounted a noble Geometrican too, *Te maris & terræ numeroque carentis arenæ Menſorem Archytæ.* Among the reſt of his Inventions, *Children's Rattles* are aſcribed to him. *Ariſtotle* calls them 'Αρχύτȣ πλαταγὴ, *Polit.* 8. i. e. *Archytas's Rattle.* And *Dioginianus*, the Grammarian, gives the Reaſon of his Invention, 'Αρχύτȣ πλαταγὴ ἐπὶ τῶν, &c. *That* Archytas's Rattle *was to quiet Children; for he having Children, contrived the Rattle, which he gave them to prevent their tumbling* [διασαλεύωσι] *other Things about the Houſe.*

To theſe Contrivances of *Archytas*, we may add *Regiomontanus*'s *Wooden Eagle, which flew forth of the City, aloft in the Air, met the Emperor a good Way off, coming towards it, and having ſaluted him, returned again, waiting on him to the City-Gates.* Alſo his *Iron Fly*, which at a Feaſt *flew forth off his Hands, and taking a Round, returned thither again.* Vide *Hakewill*, ubi ſupra, chap. x. ſect. 1.

As to other Inventions of the Antients, ſuch as of Letters, Brick, and Tiles, and building Houſes, with the Saw, Rules, and Plumber, the Lath, Augre, Glue, *&c.* alſo the making Braſs, Gold, and other Metals; the Uſe of Shields, Swords, Bows and Arrows, Boots, and other Inſtruments of War; the Pipe, Harp, and other Muſical Inſtruments; the building of Ships, and Navigation, and many other Things beſides; the Inventers of theſe, (as reported by antient Heathen Authors) may cannot the preſent or paſt Age, ſo eminent for polite Literature, for Diſcoveries and Improvements in all curious Arts and Buſineſſes, (perhaps beyond any known Age of the World; why cannot it, I ſay) diſcover thoſe hidden *Quæſita*, which may probably be reſerved for the Diſcovery of future and leſs learned Generations?

Of theſe Matters, no ſatisfactory Account can be given by any mechanical Hypotheſis, or any other Way, without taking in the Superintendence of the great Creator and Ruler of the World; who oftentimes doth manifeſt himſelf in ſome of the moſt conſiderable of thoſe Works of Men, by ſome remarkable Tranſactions of his Providence, or by ſome great Revolution or other happening in the World thereupon. Of this I might in-

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may be plenrifully met with in *Pliny*, *Nat. Hiſt.* lib. vii. cap. 56.

But in this Account of *Pliny*, we may obſerve whence the Antients (even the *Romans* themſelves in ſome meaſure) had their Accounts of theſe Matters, *viz.* from the fabulous *Greeks*, who were fond of aſcribing every Thing to themſelves *The Truth is,* (ſaith the moſt learned Biſhop *Stillingfleet*) *there is nothing in the World uſeful or beneficial to Mankind, but they have made a ſhift to find the Author of it among themſelves. If we enquire after the Original of Agriculture, we are told of* Ceres *and* Triptolemus; *if of Paſturage, we are told of an* Arcadian Pan; *if of Wine, we preſently here of a* Liber Pater: *if of Iron Inſtruments, then who but* Vulcan; *if of Muſick, none like to* Apollo. *If we preſs them then with the Hiſtory of other Nations, they are as well provided here; if we enquire an Account of* Europe, Aſia, *or* Lybia; *for the firſt, we are told a fine Story of* Cadmus's *Siſter*; *for the ſecond, of* Prometheus's *Mother of that Name*; *and for the third, of a Daughter of* Epaphus. And ſo the learned Author goes on with other particular Nations, which they boaſted themſelves to be the Founders of. *Only the grave* Athenians *thought Scorn to have any Father aſſigned them, their only Ambition was to be accounted* Aborigines & genuini Terræ. But the Ignorance and Vanity of the *Greek* Hiſtory, that learned Author hath ſufficiently refuted. *Vide* Stilling. *Orig. Sacr.* part 1. book i. chap. 4.

ſtance in the Invention of Printing *(bb)*, ſucceeded firſt by a Train of Learned Men, and the Revival of Learning, and ſoon after that by the Reformation, and the much greater Improvements of Learning at this Day. But the moſt conſiderable Inſtance I can give is, the Progreſs of Chriſtianity, by means of the civilized Diſpoſition, and large Extent of the *Roman Empire*. The latter of which, as it made way for human Power, ſo the former made way for our moſt excellent Religion into the Minds of Men. And ſo I hope, and earneſtly pray, That the Omnipotent and All-wiſe Ruler of the World will tranſact the Affairs of our moſt holy Religion, ere it be long, in the Heathen World; that the great Improvements made in the laſt, and preſent Age, in Arts and Sciences, in Navigation and Commerce, may be a Means to tranſport our Religion, as well as Name, through all the Nations of the Earth. For we find that our Culture of the more polite and curious Sciences, and our great Improvements in even the Mechanick Arts, have already made a Way for us into ſome of the largeſt and fartheſt diſtant Nations of the Earth; particularly into the great Empire of *China (cc)*.

And now, before I quit this Subject, I cannot but make one Remark, by way of Practical Inference,

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(bb) Whether *Printing* was invented in 1440, as many imagine, or was ſooner practiſed, in 1430, or 1432, as Mr. *Ellis*'s Account of the *Dutch* Inſcription, in *Phil. Tranſ.* N° 286. doth import; it is however manifeſt, how great an Influence (as it was natural) this Invention had in the promoting of Learning ſoon afterwards, mentioned before in *Note (x)*. After which followed the Reformation about the Year 1517.

(cc) The *Chineſe* being much addicted to Judicial Aſtrology, are great Obſervers of the Heavens, and the Appearances in them, rence, from what has been laſt ſaid; and that is, Since it appears, that the Souls of Men are ordered, diſpoſed, and actuated by God, even in ſecular, as well as ſpiritual Chriſtian Acts, a Duty ariſeth thence on every Man, to purſue the Ends, and anſwer all the Deſigns of the Divine Providence, in beſtowing his Gifts and Graces upon him. Men are ready to imagine their Wit, Learning, Genius, Riches, Authority, and ſuch like, to be Works of Nature, Things of Courſe, or owing to their own Diligence, Subtilty, or ſome Secondary Cauſes; that they are Maſters of them, and at Liberty to uſe them as they pleaſe, to gratify their Luſt or Humour, and ſatisfy their depraved Appetites. But it is evident, That theſe Things are the Gifts of God, they are ſo many Talents entruſted with us by the infinite Lord of the World, a Stewardſhip, a Truſt repoſed in us; for which we muſt give an Account at the Day when our Lord ſhall call; according to the parabolical Repreſentation of this Matter by our Bleſſed Saviour, *Matt.* xxxv. 14.

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them. For which Purpoſe they have an *Obſervatory* at *Pekin*, and five Mathematicans appointed to watch every Night; four towards the four Quarters of the World, and one towards the Zenith, that nothing may eſcape their Obſervation: Which Obſervations are the next Morning brought to an Office to be regiſtered. But notwithſtanding this their Diligence for many Ages, and that the Emperor hath kept in his Service above 100 Perſons, to regulate the Kalendar, yet are they ſuch mean Aſtronomers, that they owe the Regulation of their Kalendar, the Exactneſs in calculating Eclipſes, &c. to the *Europeans*; which renders the *European* Mathematicans ſo acceptable to the Emperor, that Father *Verbieſt*, and divers others, were not only made Principals in the Obſervatory, but put into Places of great Truſt in the Empire, and had the greateſt Honours paid them at their Deaths. *Vide La Comte Mem. of China*, Letter ii. &c.

Our Duty then is not to abuſe theſe Gifts of God, *not to neglect the Gift that is in us*, not to *hide our Talent in the Earth*; but, as St. *Paul* exhorteth *Timothy*, 2 *Tim.* i. 6. we muſt *ſtir up the Gift of God which is in us*, and not let it lie idle, concealed or dead; but we muſt ἀναζωπυρεῖν τὸ χάρισμα, *blow it up, and enkindle it*, as the Original imports; we muſt improve and employ our Gift to the Glory of the Giver; or in that Miniſtration, that Uſe and Service of the World, for which he gave it. Our Stewardſhip, our Craft, our Calling, be it that of Ambaſſadors of Heaven, committed to us, as it was to *Timothy (dd)*, by the laying on of Hands; or be it the more ſecular Buſineſs of the Gentleman, Tradeſman, Mechanick, or only Servant; nay, our good Genius, our Propenſity to any Good, as ſuppoſe to Hiſtory, Mathematicks, Botany, Natural Philoſophy, Mechanicks, *&c.* I ſay, all theſe Ocupations, in which the Providence of God hath engaged Men, all the Inclinations to which his Spirit hath diſpoſed them, ought to be diſcharged with that Diligence, that Care and Fidelity, that our great Lord and Maſter may not ſay to us, as was ſaid to the unfaithful Steward, *Luke* xvi. 2. *Give an Account of thy Stewardſhip, for thou mayeſt be no longer Steward*; but that he may ſay, as it is in the Parable before-cited, *Matth.* xxv. 21. *Well done thou good and faithful Servant, thou haſt been faithful over a few Things, I will make thee Ruler over many Things, enter thou into the Joy of thy Lord.* Since now the Caſe is thus, let us be perſuaded to follow *Solomon*'s Advice, *Eccleſ.* ix. 10. *Whatſoever thy Hand findeth to do, do it with thy Might (ee)*: " Lay hold on every Occaſi-

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(dd) 1 Tim. iv. 14. 2 Tim. i. 6.

(ee) Biſhop *Patrick* in loc.

“ on that preſents itſelf, and improve it with the utmoſt Diligence; becauſe now is the Time of Action, both in the Employments of the Body, and of the Mind; now is the Seaſon of ſtudying either Arts and Sciences, or Wiſdom and Virtue, for which thou wilt have no Opportunities in the Place whither thou art going in the other World. *For there is no Work, nor Device, nor Knowledge, nor Wiſdom in the Grave whither thou goeſt.*”

CHAP. II.

Of Man's Body, particularly its Poſture.

HAVING thus, as briefly as well I could, ſurveyed the *Soul*, let us next take a View of *Man's Body*. Now here we have ſuch a Multiplicity of the moſt exquiſite Workmanſhip, and of the beſt Contrivance, that if we ſhould ſtrictly ſurvey the Body from Head to Foot, and ſearch only into the known Parts, (and many more lie undiſcovered) we ſhould find too large and tedious a Taſk to be diſpatched. I ſhall therefore have time only to take a tranſient and general kind of View of this admirable Machine, and that ſomewhat briefly too, being prevented by others, particularly two excellent Authors of our own *(a)*, who have done it on the ſame Account as myſelf. And the

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(a) Mr. *Ray*, in his *Wiſdom of God manifeſted in the Works of Creation*, Part ii. And *Dr.* Cockburn's *Eſſays on Faith*, Part i. Eſſay 5.

I. Thing that preſents itſelf to our View, is the *Erect Poſture (b)* of Man's Body; which is far the moſt, if not the only commodious Poſture for a rational Creature, for him that hath Dominion over the other Creatures, for one that can invent uſeful Things, and practiſe curious Arts. For without this erect Poſture, he could not have readily turned himſelf to every Buſineſs, and on every Occaſion. His Hand *(c)* particularly could not

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(b) Ad hanc providentiam Naturæ tam diligentum [of which he had been before ſpeaking] *tamque ſolertem adjungi multa poſſunt, è quibus intelligatur, quantæ res hominibus à Deo, quamque eximiæ tributæ ſunt: qui primùm eos humo excitatos, celſos & erectos conſtituit, ut Deorum cognitionem, cœlum intuentes, capere poſſunt. Sunt enim è terrâ homines non ut incolæ, atque habitatores, ſed quaſi ſpectatores ſuperarum rerum, atque cœleſtium, quarum ſpectaculum ad nullum aliud genus animantium pertinet.* Cic. de Nat. Deor. lib. ii. cap. 56.

(c) Ut autem ſapientiſſimum animalium eſt Homo, ſic & Manus ſunt organa ſapienti animali convenientia. Nam enim quia Manus habuit, propterea eſt ſapientiſſimum, ut Anaxagoras dicebat; ſed quia ſapientiſſimum erat, propter hoc Manus habuit, ut rectiſſimè cenſuit Ariſtoteles. Non enim Manus ipſæ hominum artes docuerunt, ſed Ratio. Manus autem ipſæ ſunt artium organum, &c. Galen. de Uſ. Part lib. i. cap. 3. After which, in the reſt of this firſt Book, and Part of the ſecond, he conſiders the Particulars of the *Hand,* in order to enquire as he ſaith, cap. v. *Num eam omnino Conſtitutionem habeat* [manus] *quia meliorem alium habere non potuit.*

Of this Part, (and indeed of the other Parts of human Bodies) he gives ſo good an Account, that I confeſs I could not but admire the Skill of that ingenious and famed Heathen. For an Example, (becauſe it is a little out of the Way,) I ſhall pitch upon his Account of the different Length of the Fingers. lib. i. cap. 24. The Reaſon of this Mechaniſm, he ſaith, is, That the Tops of the Fingers may come to an Equality, *Cùm magnas aliquas moles in circuitu comprehendunt, & cùm in ſeipſis humidum vel parvum corpus continere conantur.* — *Apparent vero in unam circuli circumferentiam convenire Digiti quinque in actionibus hujuſmodi maximè quando exquiſite ſphæricum corpus comprehendunt.* And this Evenneſs of the Fingers Ends, in graſping ſpherical, and other round Bodies, he truly enough ſaith, not have been in ſo great a Readineſs to execute the Commands of the Will, and Dictates of the Soul. His Eyes would have been the moſt prone, and incommodiouſly ſituated of all Animals; but by this Situation, he can caſt his Eyes upwards, downwards, and round about him; he hath a glorious Hemiſphere of the Heavens *(d)*, and an ample Horizon on Earth *(e)*, to entertain his Eye.

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makes the Hold the firmer. And it ſeems a noble and pious Deſign he had in ſo ſtrictly ſurveying the Parts of Man's Body, which take in his own tranſlated Words, *Cùm multa namque eſſet apud veteres, tam Medicos, quam Philoſophos de utilitate particularum diſſenſio (quidam enim corpora noſtra nullis gratiâ, eſſe facta exiſtimant, nullâque omnino arte; alii autem & alicujus gratiâ, & artificioſè,—) primum quidem tantæ hujus diſſenſionis κριτήριον invenire ſtudui: deinde verò & unam aliquam univerſalem methodum conſtituere, quâ ſingularum partium corporis, & eorum quæ illis accidunt utilitatem invenire poſſemus,* Ibid cap. 8.

(d) Pronaque cum ſpectant animalia cætera terram,
Os Homini ſublime dedit, cælumque tueri
Juſſit, & erectos ad ſidera tollere vultus.
Ovid. Metam. lib. i. car. 84.

(e) If any ſhould be ſo curious, to deſire to know how far a Man's Proſpect reacheth, by Means of the Height of his Eye, ſuppoſing the Earth was an uninterrupted Globe; the Method is a common Caſe of right-angled plain Triangles, where two Sides, and an oppoſite Angle are given: Thus in *Fig.* 4. *AHB* is the Surface, or a great Circle of the terraqueous Globe; *C* the Center, *HC* its Semidiameter, *E* the *Height* of the Eye; and foraſmuch as *HE* is a Tangent, therefore the Angle at *H* is a right Angle: So that there are given *HC* 398, 386 Miles, or 21034781 *Engliſh* Feet, (according to *Book* II. *Chap.* ii. *Note (a)*;) *CE* the ſame Length with the Height of the Eye, on the Maſt of a Ship. or at only a Man's Height, *&c.* added to it; and *EHC* the oppoſite right Angle. By which three Parts given, it is eaſy to find all the other Patts of the Triangle. And firſt, The Angle at *C*, in order to find the Side *HE*, the Proportion is, as the Side *CE*, to the Angle at *H*; ſo the Side *HC*, to the Angle at *E*, which being ſubſtracted out of

And as this Erection of Man's Body is the moſt complete Poſture for him; ſo if we ſurvey the Proviſion made for it, we find all done with manifeſt Deſign, the utmoſt Art and Skill being employed therein. To paſs by the particular Conformation of many of the Parts, the Ligaments and Faſtnings to anſwer this Poſture; as the Faſtnings, for In-

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90 *gr.* the Remainder is the Angle at *C*. And then, as the Angle at *E*, is to its oppoſite Side *HC*, or elſe as the Angle at *H* is to its oppoſite Side *CE*; ſo the Angle at *C*, to its oppoſite Side *EH*, the viſible Horizon. Or the Labour may be ſhortened, by adding together the Logarithm of the Sum of the two given Sides, and the Logarithm of their Difference; the Half of which two Logarithms, is the Logarithm of the Side required, nearly. For an Example, We will take the two Sides in Yards. By reaſon ſcarce any Table of Logarithms will ſerve us farther. The Semidiameter of the Earth is 7011594 Yards; the Height of the Eye is two Yards more, the Sum of both Sides, is 14023190.

Logar. of which Sum is, - -	7,1468468
Logar. of two Yards (the Difference) is,	0,3010300
Sum of both Logar. - - - - -	7,4478768
The half Sum, - - - - -	3.7239384

is the Logarithm of 5296 Yards = three Miles, which is the Length of the Line *EH*, or Diſtance the Eye can reach at ſix Feet Height.

This would be the Diſtance, on a perfect Globe, did the viſual Rays come to the Eye in a ſtrait Line; but by Means of the Rarefractions of the Atmoſphere, diſtant Objects on the Horizon, appear higher than really they are, and may be ſeen at a greater Diſtance, eſpecially on the Sea; which is a Matter of great Uſe, eſpecially to diſcover at Sea the Land, Rocks, *&c.* and it is a great Act of the Divine Providence, in the Contrivance and Convenience of the Atmoſphere, which by this Means enlargeth the viſible Horizon, and is all one, as if the Terraqueous Globe was much larger than really it is. As to the Height of the Apparent above the true Level; or, how much diſtant Objects are raiſed by the Refractions, the ingenious and accurate Gentlemen of the *French Academy Royal*, have given us a Table in their *Meaſures of the Earth*, Art. 12.

ſtance, of the *Pericardium* to the *Diaphragm*, (which is peculiar to Man *(f)*; I ſay, paſſing by a deal of this Nature, manifeſting this Poſture to be an Act of Deſign,) let us ſtop a little at the curious Fabrick of the Bones, thoſe Pillars of the Body. And how artificially do we find them made, how curiouſly placed from the Head to the Foot! The *Vertebræ* of the Neck and Back-bone *(g)*, made ſhort and complanated and firmly braced with Muſcles and Tendons, for eaſy Incurvations of the Body; but withal for greater Strength, to ſupport the Body's own Weight, together with other additional Weights it may have Occaſion to bear. The *Thigh-bones* and Legs long, and ſtrong, and every Way well fitted for the Motion of the Body. The *Feet* accommodated with a great *Number of Bones*, curiouſly and firmly tacked together, (to which muſt be added the Miniſtry of the Muſcles *(h)*, to anſwer all the Motions

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(f) See *Book* VI. *Chap.* 5. *Note (g).*

(g) See *Book* IV. *Chap.* 8. *Note (c).*

(h) The Mechaniſm of the Foot would appear to be wonderful, if I ſhould deſcend to a Deſcription of all its Parts; but that would be two long for theſe Notes; therefore a brief Account, (moſt of which I owe to the before-commended Mr. *Cheſelden*,) may ſerve for a Sample: In the firſt Place, it is neceſſary the Foot ſhould be concave, to enable us to ſtand firm, and that the Nerves and Blood-Veſſels may be free from Compreſſion, when we ſtand or walk. In order hereunto, the long *Flexors* of the Toes croſs one another at the Bottom of the Foot, in the Form of a St. *Andrew's* Croſs, to incline the leſſer Toes towards the great One, and the great One towards the leſſer. The *ſhort Flexors* are chiefly concerned in drawing the Toes towards the Heel. The *tranſverſalis Pedis* draws the Outſides of the Foot towards each other; and by being inſerted into one of the *ſeſamoid* Bones of the great Toe, diverts the Power of the *abductor Muſcle*, falſly ſo called, and makes it become a *Flexor*. And laſtly, The *peronæus Longus* runs round the outer Ankle, and obliquely forwards croſs the Bottom of the Foot, and at once

Motions of the Legs and Thighs, and at the ſame Time to keep the Body upright, and prevent its falling, by readily aſſiſting againſt every Vacillation thereof, and with eaſy and ready Touches keeping the *Line of Innexion*, and *Centre of Gravity*, in due Place and Poſture *(i)*.

And as the Bones are admirably adapted to prop; ſo all the Parts of the Body are as incomparably placed to poiſe it. Not one Side too heavy for the other; but all in nice Æquipoiſe: The Shoulders, Arms, and Side æquilibrated on one Part; on the other Part of the *Viſcera* of the Belly counterpoiſed with the Weight of the ſcapular Part, and that uſeful Cuſhion of Fleſh behind,

And laſtly, to all this we may add the wonderful Concurrence, and Miniſtry, of the prodigious Number and Variety of Muſcles, placed throughout the Body for this Service; that they ſhould ſo readily anſwer to every Poſture, and comply with every Motion thereof, without any previous Thought or Reflex Act, ſo that as the excellent *Borelli (k)* ſaith, " It is worthy of Admiration, that " in ſo great a Variety of Motions, as Running, " Leaping, and Dancing, Nature's Laws of Æqua- " libration ſhould always be obſerved; and when " neglected, or wilfully tranſgreſſed, that the Body " muſt neceſſarily and immediately tumble down.

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once helps to extend the *Tarſus*, to conſtrict the Foot, and to direct the Power of the other *Extenſors* towards the Ball of the great Toe: Hence the Loſs of the great Toe, is more than of all the other Toes. See alſo Mr. *Cowper's Anat.* Tab. 28, *&c.*

(i) It is very well worth while to compare here what *Borelli* ſaith, *De Motu Animal.* Par. i. cap. 18. *De ſtatione Animal.* Prop. 132, *&c.* To which I refer the Reader, it being too long to recite here.

(k) Borel. ibid. Prop. 142.

CHAP.

CHAP. III.

Of the Figure and Shape of Man's Body.

THE Figure and Shape of Man's Body, is the moſt commodious that could poſſibly be invented for ſuch an Animal; the moſt agreeable to his Motion, to his Labours, and all his Occaſions. For had he been a rational Reptile, he could not have moved from Place to Place faſt enough for his Buſineſs, nor indeed have done any almoſt. Had he been a rational Quadrupede, among other Things, he had loſt the Benefit of his Hands, thoſe noble Inſtruments of the moſt uſeful Performances of the Body. Had he been made a Bird, beſides many other great Inconveniencies, thoſe before-mentioned of his Flying would have been ſome. In a Word, any other Shape of Body, but that which the All-wiſe Creator hath given Man, would have been as incommodious, as any Poſture but that of erect; it would have rendered him more helpleſs, or have put it in his Power to have been more pernicious, or deprived him of Ten thouſand Benefits, or Pleaſures, or Conveniences, which his preſent Figure capacitates him for.

CHAP. IV.

Of the Stature and Size of Man's Body.

AS in the Figure, ſo in the Stature and Size of Man's Body, we have another manifeſt Indication of excellent Deſign. Not too Pygmean *(a)*, nor too Gigantick *(b)*, either of which Sizes would in ſome Particular or other, have been incommodious to himſelf, or to his Buſineſs, or to the reſt of his Fellow-Creatures. Too Pygmean would have rendered him too puny a Lord of the Creation; too impotent, and unfit to manage the inferior Creatures; would have expoſed him to the Aſſaults of the weakeſt Animals, to the ravening Appetite of voracious Birds, and have put him in the Way, and endangered his being trodden in the Dirt by the larger Animals. He would have been alſo too weak for his Buſineſs, unable to carry Burdens; and, in a Word, to tranſact the greater Part of his Labours and Concerns.

And on the other hand, had Man's Body been made too monſtrouſly ſtrong, too enormouſly Gi-

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(a) What is here urged about the Size of Man's Body, may anſwer one of *Lucretius*'s Reaſons, why *Nil ex nihilo gignitur.* His Argument is.

Denique cur Homines tantos natura parare
Non potuit, pedibus qui pontum per vade poſſent
Tranſire, & magnos manibus divellere monteis?
Lucret. lib. i. carm. 200.

(b) Haud facile fit ut quiſquam & ingentes corporis vires, & ingenium ſubtile habeat. Diodor. Sic. lib. xvii.

gantick *(c)*, it would have rendered him a dangerous

(c) Although we read of *Giants* before *Noah*'s Flood, *Gen.* vi. 4. and more plainly afterwards in *Numb.* xiii. 33. yet there is great Reaſon to think the Size of Man was always the ſame from the Creation. For as to the *Nephilim*, or *Giants*, in *Gen.* vi. the Antients vary about them; ſome taking them for great Atheiſts, and Monſters of Impiety, Rapine, Tyranny, and all Wickedneſs, as well as of monſtrous Stature, according as indeed the *Hebrew* Signification allows.

And as for the *Nephilim*, in *Numb.* xiii. which were evidently Men of a Gigantick Size, it muſt be conſidered, that it is very probable, the Fears and Diſcontentments of the Spies might add ſomewhat thereunto.

But be the Matter as it will, it is very manifeſt, that in both theſe Places, *Giants* are ſpoken of as Rarities and Wonders of the Age, not of the common Stature. And ſuch Inſtances we have had in all Ages; excepting ſome fabulous Relations; ſuch as I take to be that of *Theutobocchus*, who is ſaid to have been dug up, *Anno* 1613, and to have been higher than the Trophies, and 26 Feet long; and no better I ſuppoſe the Giants to have been that *Ol. Magnus* gives an Account of, in his 5th Book, ſuch as *Harthen*, and *Starchater*, among the Men; and among the Women, *Reperta eſt* (ſaith he) *puella — in capite vulnerata, ac mortua, induta chlamyde purpureâ, longitudinis cubitorum* 50, *latitudinis inter humeros quatuor.* Ol. Mag. Hiſt. lib. v. cap. 2.

But as for the more credible Relations of *Goliath*, (*whoſe Height was* 6 *Cubits and a Span*, 1 Sam. xvii. 4. which, according to the late curious and learned Lord Biſhop of *Peterborough*, is ſomewhat above 11 Feet *Engliſh*, *vid.* Biſhop *Cumberland of Jewiſh Weights and Meaſures*,) of *Maximus* the Emperor, who was 9 Feet high, and others in *Auguſtus*, and other Reigns, of about the ſame Height: To which we may add, the Dimenſions of a *Skeleton*, dug up lately in the Place of a *Roman* Camp near *St. Albans*, by an Urn, inſcribed, *Marcus Antoninus*; of which an Account is given by Mr. *Cheſelden*, who judgeth by the Dimenſions of the Bones, that the Perſon was 8 Feet high. *Vide Philoſ. Tranſ.* N°. 333. Theſe antique Examples and Relations, I ſay, we can match, yea, out-do, with modern Examples; of which we have divers in *J. Ludolph. Comment. in Hiſt. Æthiop.* lib. i. cap. 2. ſect. 22. *Magus*, *Conringius*, Dr. *Hakewill*, and others. Which latter relates from *Nannez*, of Porters and Archers belonging to the Emperor of *China*, of 15 Feet high; and others from *Purchas*, tous Tyrant in the World, too ſtrong (*d*), in ſome Reſpects,

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of 10 and 12 Feet high, and more. See the learned Author's *Apolog.* p. 208.

Theſe indeed exceed what I have ſeen in *England*; but in 1684, I myſelf meaſured an *Iriſh* Youth, ſaid to be not 19 Years old, who was 7 Feet near 8 Inches; and in 1697, a Woman who was 7 Feet 3 Inches in Height.

But for the ordinary Size of Mankind, in all Probability, it was always (as I ſaid) the ſame, as may appear from the Monuments, Mummies, and other antient Evidences to be ſeen at this Day. The moſt antient Monument at this Day, I preſume, is that of *Cheops*, in the firſt and faireſt Pyramid of *Egypt*; which was, no doubt, made of Capacity every way ſufficient to hold the Body of ſo great a Perſon as was intended to be laid up in it: But this we find, by the nice Meaſures of our curious Mr. *Greaves*, hardly to exceed our common Coffins. *The hollow Part within* (ſaith he) *is in Length* only 6,488 *Feet*, and *in Breadth* but 2,218 *Feet: the Depth* 2,860 *Feet. A narrow Space, yet large enough to contain a moſt potent and dreadful Monarch, being dead; to whom living, all* Egypt *was too ſtreight and narrow a Circuit. By theſe Dimenſions, and by ſuch other Obſervations, as have been taken by me from ſeveral embalmed Bodies in* Egypt, *we may conclude there is no Decay in Nature, (though the Queſtion is as old as* Homer,*) but that the Men of this Age are the ſame Stature they were near* 3000 *Years ago.* Vide *Greaves* of the Pyram. in 1638, in *Ray*'s Collect. of *Trav.* Tom. i. p. 118.

To this more antient, we may add others of a later Date. Of which take theſe, among others, from the curious and learned *Hakewill.* The Tombs at *Piſa*, that are ſome thouſand Years old, are not longer than ours; ſo is *Athelſtane*'s in *Malmeſbury* Church; ſo *Sebba*'s in St. *Paul*'s, of the Year 693; ſo *Etheldred*'s, &c. Apol. 216, *&c.*

The ſame Evidence we have alſo from the Armour, Shields, Veſſels, and other Utenſils dug up at this Day. The Braſs Helmet dug up at *Metaurum*, which was not doubted to have been left there at the *Overthrow of Aſdrubal*, will fit one of our Men at this Day.

Nay, beſides all this, probably we have ſome more certain Evidence. *Auguſtus* was 5 Feet 9 Inches high, which was the juſt Meaſure of our famous Queen *Elizabeth*, who exceeded his Height 2 Inches, if proper Allowance be made for the Difference between the *Roman* and our Foot. *Vide* Hakew. *ib. p.* 215.

(*d*) To the Stature of Men in the foregoing Note, we may add

Reſpects, even for his own Kind, as well as the other Creatures. Locks and Doors might perhaps have been made of ſufficient Strength to have barricaded our Houſes; and Walls, and Ramparts

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add ſome Remarks about their unuſual *Strength*. That of *Sampſon* (who is not ſaid to have exceeded other Men in Stature, as he did in Strength) is well known. So of old, *Hector*, *Diomedes*, *Hercules*, and *Ajax*, are famed; and ſince them many others; for which I ſhall ſeek no farther than the before-commended *Hakewill*, who by his great and curious Learning, hath often moſt of the Examples that are to be met with, on all his Subjects he undertakes. Of the After-Ages he names *C. Marius*, *Maximinus*, *Aurelian*, *Scanderberg*, *Bardeſin*, *Tamerlane*, *Siſka*, and *Hunniades*. Anno 1529, *Klunker*, Provoſt of the great Church at *Miſnia*, carried a Pipe of Wine out of the Cellar, and laid it in the Cart. *Mayolus* ſaw one hold a Marble Pillar in his Hand 3 Feet long, and 1 Foot diameter, which he toſſed up in the Air, and catched again, as if it were a Ball. Another of *Mantua*, and a little Man, named *Rodamas*, could break a Cable, &c. *Ermando Burg* fetched up Stairs an Aſs laden with Wood, and threw both into the Fire. At *Conſtantinople*, *Anno* 1582, one lifted a Piece of Wood, that twelve Men could ſcarce raiſe; then lying along, he bare a Stone that ten Men could but juſt roll to him. *G.* of *Fronſberge*, Baron *Mindleheim*, could raiſe a Man off his Seat, with only his middle Finger; ſtop an Horſe in his full Career; and ſhove a Cannon out of its Place. *Cardan* ſaw a Man dance with two Men in his Arms, two on his Shoulders, and one on his Neck. *Patacoua*, Captain of the *Coſſacks*, could tear an Horſe-ſhoe; (and, if I miſtake not, the ſame is reported of the preſent King *Auguſtus* of *Poland*) A Gigantick Woman of the *Netherlands* could lift a Barrel of *Hamburg* Beer. Mr. *Carew* had a Tenant that could carry a Butt's Length, 6 Buſhels of Wheaten Meal (of 15 Gallons Meaſure) with the Lubber the Miller, of 24 Years of Age, on the Top of it. And *J. Roman*, of the ſame County, could carry the Carcaſs of an Ox. *Vide* Hakewill, *ib. p.* 238.

Viros aliquot moderna memoria tam à mineralibus, quàm aliis Seuthiæ & Gothiæ provinciis adducere congruit, tantâ fortitudine præditos, ut quiſque eorum in humeros ſublevatum Equum, vel Bovem maximum, imò vas ferri 600, 800, *aut* 1000 *librarum (quale & aliquæ Puellæ levare poſſunt,) ad plura ſtadia portaret,* Ol. Mag. ubi ſupra.

might perhaps have been made ſtrong enough to have fenced our Cities. But theſe Things could not have been without a great and inconvenient Expence of Room, Materials, and ſuch Neceſſaries, as ſuch vaſt Structures and Uſes would have occaſioned; more perhaps than the World could have afforded to all Ages and Places. But let us take the Deſcant of a good Naturaliſt and Phyſician on the Caſe *(e)*. "Had Man been a Dwarf, " (ſaid he) he had ſcarce been a reaſonable Crea- " ture; For he muſt then have had a Jolt Head; " ſo there would not have been Body and Blood " enough to ſupply his Brain with Spirits; or he " muſt have had a ſmall Head, anſwerable to his " Body, and ſo there would not have been Brain " enough for his Buſineſs.—Or had the Species of " Mankind been Gigantick, he could not have " been ſo commodiouſly ſupplied with Food: For " there would not have been Fleſh enough of the " beſt edible Beaſts, to ſerve his Turn. And if " Beaſts had been made anſwerably bigger, there " would not have been Graſs enough. And ſo he goeth on. And a little after, "There would not " have been the ſame Uſe and Diſcovery of his " Reaſon; in that he would have done many " Things by mere Strength, for which he is now " put to invent innumerable Engines.—Neither " could he have uſed an Horſe, nor divers other " Creatures. But being of a middle Bulk, he is " fitted to manage and uſe them all. For (ſaith " he) no other Cauſe can be aſſigned, why a Man " was not made five or ten times bigger, but his " Relation to the reſt of the Univerſe." Thus far our curious Author.

(e) Grew's *Coſmol. Sacr. B.* 1. *Ch.* 5. *ſect.* 25.

CHAP.

CHAP. V.

Of the Structure of the Parts of Man's Body.

HAVING thus taken a View of the Poſture, Shape, and Size of Man's Body, let us in this Chapter ſurvey the Structure of its Parts. But here we have ſo large a Proſpect, that it would be endleſs to proceed upon Particulars. It muſt ſuffice therefore to take Notice, in general only, how artificially every Part of our Body is made. No Botch, no Blunder, no unneceſſary *Apparatus*, (or in other Words) no Signs of Chance*(a)*; but every Thing curious, orderly, and performed in the ſhorteſt and beſt Method, and adapted to the moſt compendious Uſe. What one Part is there throughout the whole Body, but what is compoſed of the fitteſt Matter for that Part; made of the moſt proper Strength and Texture; ſhaped in the compleateſt Form; and, in a Word,

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(a) It is manifeſtly an Argument of Deſign, That in the Bodies of different Animals, there is an Agreement of the Parts, ſo far as the Occaſions and Offices agree; but a Difference of thoſe, where there is a Difference of theſe. In an Human Body are many Parts agreeing with thoſe of a Dog, for Inſtance; but in his Forehead, Fingers, Hand, Inſtruments of Speech, and many other Parts, there are Muſcles, and other Members, which are not in a Dog. And ſo contrariwiſe in a Dog, which is not in a Man. If the Reader is minded to ſee what particular Muſcles are in a Man, that are not in a Dog; or in a Dog, that are not in an Human Body, let him conſult the curious and accurate Anatomiſt, Dr. *Douglaſs*'s *Myogr. compar.*

accoutered with every Thing neceſſary for its Motion, Office, Nouriſhment, Guard, and what not! What ſo commodious a Structure and Texture could have been given to the Bones, for Inſtance, to make them firm and ſtrong, and withal light, as that which every Bone in the Body hath? Who could have ſhaped them ſo nicely to every Uſe, and adapted them to every Part, made them of ſuch juſt Lengths, given them ſuch due Sizes and Shapes, channelled, hollowed, headed, lubricated, and every other Thing miniſtring, in the beſt and moſt compendious Manner to their ſeveral Places and Uſes? What a glorious Collection and Combination have we alſo of the moſt exquiſite Workmanſhip and Contrivance in the Eye, in the Ear, in the Hand (*b*), in the Foot (*c*), in the Lungs, and other Parts already mentioned? What an Abridgment of Art, what a Variety of Uſes (*d*) hath Nature

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(*b*) *Galen* having deſcribed the Muſcles, Tendons, and other Parts of the Fingers, and their Motions, cries out, *Conſidera igitur etiam hic mirabilem* CREATORIS *ſapientiam!* De Uſ. Part. lib. i. cap. 18.

(*c*) And not only in the Hand, but in his Account of the Foot (lib. iii.) he frequently takes Notice of what he calls, *Artem, Providentiam & Sapientiam Conditoris.* As cap. xiii. *An igitur non æquum eſt hic quoque admirari Providentiam Conditoris, qui ad utrumque uſum, etſi certè contrarium, exactè convenientes & conſentientes invicem fabricatus eſt totius membri* [tibiæ] *particulas?* And at the End of the Chap. *Quòd ſi omnia quæ ipſarum ſunt partium mente immutaverimus, neque invenerimus poſitionem aliam meliorem eâ quam nunc ſortita ſunt, neque figuram, neque magnitudinem, neque connexionem, neque (ut paucis omnia complectar) aliud quidquam eorum, quæ corporibus neceſſariò inſunt, perfectiſſimam pronunciare oportet, & undique rectè conſtitutam præſentem ejus conſtructionem.* The like alſo concludes, chap. 15.

(*d*) *At enim Opificis induſtrii maximum eſt indicium (quemadmodum antè ſæpenumerò jam diximus) iis quæ ad alium uſum fuerunt comparata, ad alias quoque utilitates abuti, neque laborare ut ſingulis utilitatibus ſingulas faciat proprias particulas.* Galen ubi ſupra, lib. ix. cap. 5.

laid upon that one Member the Tongue, the grand Inſtrument of Taſte, the faithful Judge, the Centinel, the Watchman of all our Nouriſhment, the artful Modulator of our Voice, the neceſſary Servant of Maſtication, Swallowing, Sucking, and a great deal beſides? But I muſt deſiſt from proceeding upon Particulars, finding I am fallen upon what I propoſed to avoid.

And therefore, for a Cloſe of this Chapter, I ſhall only add Part of a Letter I received from the before commended very curious and ingenious Phyſician Dr. *Tancred Robinſon*: *What* (ſaith he) *can poſſibly be better contrived for animal Motion and Life, than the quick Circulation of the Blood and Fluids, which run out of Sight in capillary Veſſels, and very minute Ducts, without Impediment, (except in ſome Diſeaſes,) being all directed to their peculiar Glands and Channels, for the different Secretion, ſenſible and inſenſible; whereof the laſt is far the greateſt in Quantity and Effects, as to Health and Sickneſs, acute Diſtempers frequently ariſing from a Diminution of Tranſpiration, through the cutaneous Chimneys, and ſome chronical Ones, from an Augmentation: Whereas, Obſtructions in the Liver, Pancreas, and other Glands, may only cauſe a Schirrus, a Jaundice, an Ague, a Dropſy, or other ſlow Diſeaſes. So an Increaſe of that Secretion may accompany the general Colliquations, as in Fluxes, hectick Sweats and Coughs, Diabetes, and other Conſumptions. What a mighty Contrivance is there to preſerve theſe due Secretions from the Blood, (on which Life ſo much depends,) by frequent Attritions, and Communications of the Fluids in their Paſſage through the Heart, the Lungs, and the whole Syſtem of the Muſcles? What Mæanders and Contortions of Veſſels, in the Organs of Separation? And, What a Concourſe of Elaſtick Bodies from the Air, to ſupply the Springs, and continual Motion of ſome Parts, not only in Sleep, and Reſt; but in long violent Exerciſes of the*

Muſcles? Whoſe Force drive the Fluids round in a wonderful rapid Circulation through the minuteſt Tubes, aſſiſted by the conſtant Pabulum of the Atmoſphere, and their own Elaſtick Fibres, which impreſs that Velocity on the Fluids.

Now I have mentioned ſome Uſes of the Air, in carrying on ſeveral Functions in animal Bodies; I may add the Share it hath in all the Digeſtions of the ſolid and fluid Parts. For when this Syſtem of Air comes, by Divine Permittance, to be corrupted with poiſonous, acrimonious Steams, either from the Earth, from Merchandiſe, or infected Bodies, what Havock is made in all the Operations of living Creatures? The Parts gangrene, and mortify under Carbuncles, and other Tokens: Indeed the whole Animal Oeconomy is ruined; of ſuch Importance is the Air to all the Parts of it. Thus my learned Friend.

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CHAP.

CHAP. VI.

Of the Placing the Parts of Man's Body.

IN this Chapter I propoſe to conſider the Lodgment of the curious Parts of Man's Body, which is no leſs admirable than the Parts themſelves, all ſet in the moſt convenient Places of the Body, to miniſter to their own ſeveral Uſes and Purpoſes, and aſſiſt, and mutually to help one another. Where could thoſe faithful Watchmen the Eye, the Ear, the Tongue, be ſo commodiouſly placed, as in the upper Part of the Building? Where could we, throughout the Body, find ſo proper a Part to lodge four of the five Senſes, as in the Head *(a)*, near the Brain *(b)*, the common Senſory, a Place well guarded, and of little other Uſe than to be a Seat to thoſe Senſes? And, How could we lodge the fifth Senſe, that of *Touching*, otherwiſe *(c)*, than to diſperſe it to all Parts of the

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(a) Senſus, interpretes ac nuntii rerum, in capite, tanquam in arce, mirificè ad uſus neceſſarios & facti, & collocati ſunt. Nam oculi tanquam ſpeculatores, altiſſimum locum obtinent; ex quo plurima conſpicientes, fungantur ſuo munere. Et aures cum ſonum recipere debeant, qui naturâ in ſublime fertur; rectè in illis corporum partibus collocatæ ſunt. Cicer. de Nat. Deor. lib. ii. cap. 56. ubi plura de cæteris Senſibus.

(b) Galen well obſerves, That the Nerves miniſtring to Motion, are hard and firm, to be leſs ſubject to Injury; but thoſe miniſtring to Senſe, are ſoft and tender; and that for this Reaſon it is, that four of the five Senſes are lodged ſo near the Brain, *viz.* partly to partake of the Brain's Softneſs and Tenderneſs, and partly for the Sake of the ſtrong Guard of the Skull. *Vid. Gal. de Uſ. Part.* lib. viii. chap. 5, 6.

(c) See *Book* IV. *Chap.* 6. *Note (c)*.

Body? Where could we plant the Hand *(d)*, but juſt where it is, to be ready at every Turn, on all Occaſions of Help and Defence, of Motion, Action, and every of its uſeful Services? Where could we ſet the Legs and Feet, but where they are, to bear up, and handſomely to carry about the Body? Where could we lodge the Heart, to labour about the whole Maſs of Blood, but in, or near the Centre of the Body *(e)*? Where could we find Room for that noble Engine to play freely in? Where could we ſo well guard it againſt external Harms, as it is in that very Place in which it is lodged and ſecured? Where could we more commodiouſly place, than in the Thorax and Belly, the uſeful *Viſcera* of thoſe Parts, ſo as not to ſwag, and jog, and over-ſet the Body, and yet to miniſter ſo harmoniouſly, as they do, to all the ſeveral Uſes of Concoction, Sanguification, the Separation of various Ferments from the Blood, for the great Uſes of Nature, and to make Diſcharges of what is uſeleſs, or would be burthenſome or pernicious to the Body *(f)*? How could we plant the curious and great Variety of Bones, and of Muſcles, of all Sorts and Sizes, neceſſary, as I have ſaid, to the Support, and every Motion of the Body? Where could we lodge all the Arteries and Veins, to convey Nouriſhment; and the Nerves, Senſation throughout the Body? Where, I ſay, could we lodge all theſe Implements of the Body, to perform their ſeveral Offices? How could we ſecure and guard them ſo well,

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(d) Quàm verò aptas, quamque multarum artium miniſtras Manus natura homini dedit? The particulars of which, enumerated by him, ſee in *Cic. ubi ſupra*, cap. 60.

(e) See *Book* VI. *Chap.* 5.

(f) Ut in edificiis Architecti avertunt ab oculis & naribus dominorum ea, quæ profluentia neceſſariò tetri eſſent aliquid habitura; ſic natura res ſimiles (ſcil. excrementa) procul amandavit à ſenſibus. Cicer. de Nat. Deor. lib. ii. cap. 56.

as in the very Places, and in the ſelf-ſame Manner in which they are already placed in the Body? And laſtly, to name no more, What Covering, what Fence could we find out for the whole Body, better than that of Nature's own providing, the Skin? *(g)* How could we ſhape it to, or brace it about every Part better, either for Convenience or Ornament? What better Texture could we give it, which although leſs obdurate and firm, than that of ſome other Animals; yet is ſo much the more ſenſible of every Touch, and more compliant with every Motion? And being eaſily defenſible by the Power of Man's Reaſon and Art, is therefore much the propereſt Tegument for a reaſonable Creature.

(g) Compare here *Galen*'s Obſervations *de Uſ. Part.* lib. xi. cap. 15. Alſo lib. ii. cap. 6. See alſo *Cowper. Anat.* where in *Tab.* 4. are very elegant Cuts of the Skin in divers Parts of the Body, drawn from microſcopical Views; as alſo of the *papillæ Pyramidales*, the *ſudoriferous Glands* and Veſſels, the *Hairs*, &c.

CHAP. VII.

Of the Proviſion in Man's Body againſt Evils.

HAVING taken a tranſient View of the Structure, and Lodgment of the Parts of human Bodies; let us next conſider the admirable Proviſion that is made throughout Man's Body, to ſtave off Evils, and to diſcharge *(a)* them when befallen. For the Prevention of Evils, we may take the Inſtances already given, of the Situation of thoſe faithful Sentinels, the Eye, the Ear, and Tongue, in the ſuperior Part of the Body, the better to deſcry Dangers at a Diſtance, and to call out preſently for Help. And how well ſituated is the Hand to be a ſure and ready Guard to the Body, as well as the faithful Performer of moſt of its Services? The Brain, the Nerves, the Arteries, the Heart *(b)*, the

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(a) One of Nature's moſt conſtant Methods here, is by the *Glands*, and the *Secretions* made by them; the Particulars of which being too long for theſe Notes, I ſhall refer to the modern Anatomiſts, who have written on theſe Subjects; and indeed who are the only Men that have done it tolerably: Particularly, our learned Doctors *Cockburn*, *Keil*, *Morland*, and others at Home and Abroad: An Abridgment of whoſe Opinions and Obſervations, for the Reader's Eaſe, may be met with in Dr. *Harris*'s *Lex. Tech. Vol.* ii. under the Words *Glands*, and *Animal Secretion.*

(b) In Man, and moſt other Animals, the Heart hath the Guard of Bones; but in the *Lamprey*, which hath no Bones, (no not ſo much as a Back-bone,) *the Heart is very ſtrangely ſecured, and lies immur'd, or capſulated in a Cartilage, or griſly Subſtance, which includes the Heart, and its Auricle, as the Skull — doth the Brain in other Animals.* Power's Microſ. Obſ. 22.

Lungs; and, in a Word, all the principal Parts, how well are they barricaded, either with ſtrong Bones, or deep Lodgments in the Fleſh, or ſome ſuch the wiſeſt and fitteſt Method, moſt agreeable to the Office and Action of the Parts? Beſides which, for greater Precaution, and a farther Security, what an incomparable Proviſion hath the infinite Contriver of Man's Body made for the Loſs of, or any Defect in, ſome of the Parts we can leaſt ſpare, by doubling them? By giving us two Eyes, two Ears, two Hands, two Kidneys, two Lobes of the Lungs, Pairs of the Nerves, and many Ramifications of the Arteries and Veins in the fleſhy Parts, that there may not be a Defect of Nouriſhment of the Parts in Caſes of Amputation, or Wounds, or Ruptures of any of the Veſſels.

And as Man's Body is admirably contrived, and made to prevent Evils; ſo no leſs Art and Caution hath been uſed to get rid of them, when they do happen. When by any Misfortune, Wounds or Hurts do befal; or, when by our own wicked Fooleries and Vices, we pull down Diſeaſes and Miſchiefs upon ourſelves, what Emunctories (c), what admirable Paſſages (d), are diſperſed throughout

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(c) *Here* [from the Puſtules he obſerved in Monomotapa] *were Grounds to admire the Contrivance of our Blood, which on ſome Occaſions, ſo ſoon as any Thing deſtructive to the Conſtitution of it, comes into it, immediately by an Inteſtine Commotion, endeavoureth to thruſt it forth, and is not only freed from the new Gueſt; but ſometimes what likewiſe may have lain lurking therein —for a great while. And from hence it comes to paſs, That moſt Part of Medicines, when duly adminiſtred, are not only ſent out of the Body themſelves; but likewiſe great Quantities of morbifick Matter: As in Salivation,* &c. Dr. *Sloane*'s Voy. to *Jamaica*, p. 25.

(d) *Valſalva* diſcovered ſome Paſſages into the Region of the *Ear-drum,* of mighty Uſe (among others,) to make Diſcharges of Bruiſes, Impoſthumes, or any purulent, or morbifick Matter from the Brain, and Parts of the Head. Of which he out the Body; what incomparable Methods doth Nature take (e); what vigorous Efforts is ſhe enabled

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he gives two Examples: One a Perſon, who from a Blow on his Head, had diſmal Pains therein, grew ſpeechleſs, and lay under an abſolute Suppreſſion and Decay of his Strength; but found certain Relief, whenever he had a Flux of Blood, or purulent Matter out of his Ear; which after his Death *Valſalva* diſcovered, was through thoſe Paſſages.

The other was an *Apoplectical Caſe*, wherein he found a large Quantity of extravaſated Blood, making Way from the Ventricles of the Brain, though thoſe ſame Paſſages. *Valſal. de Aure hum.* cap. ii. ſect. 14. and cap. v. ſect. 8.

(e) *Hippocrates Lib. de Alimentis*, takes Notice of the Sagacity of Nature, in finding out Methods and Paſſages for the diſcharging Things offenſive to the Body, of which the late learned and ingenious Biſhop of *Clogher*, in *Ireland*, (*Boyle*,) gave this remarkable Inſtance, to my very curious and ingenious Neighbour and Friend, D'*Acre Barret*, Eſq; *viz.* That in the Plague-Year, a Gentleman at the Univerſity had a large Plague-Sore gathered under his Arm, which, when they expected it would have broken, diſcharged itſelf by a more than ordinary large and fœtid Stool; the Sore having no other Vent for it, and immediately becoming ſound and well thereon.

Like to which, is the Story of *Joſ. Lanzonius*, of a Soldier of thirty-five Years of Age, who had a Swelling in his right Hip, accompanied with great Pain, &c. By the Uſe of emollient Medicines, having ripened the Sore, the Surgeon intended the next Day to have opened it; but about Midnight, the Patient having great Provocations to Stool, diſburthened himſelf three Times; immediately upon which, both the Tumour and Pain ceaſed, and thereby diſappointed the Surgeon's Intentions. *Ephem. Germ. Anno* 1690. *Obſ.* 49. More ſuch Inſtances we find of Mr. *Tonges*, in *Philoſoph. Tranſ.* N° 323. But indeed there are ſo many Examples of this Nature in our *Philoſoph. Tranſ.* in *Ephem. German. Tho. Bartholine*, *Rhodius*, *Sennertus*, *Hildanus*, &c. that it would be endleſs to recount them. Some have ſwallowed Knives, Bodkins, Needles and Pins, Bullets, Pebbles, and twenty other ſuch Things as could not find a Paſſage the ordinary Way, but have met with an *Exit* through the Bladder, or ſome other Way of Nature's own providing. But paſſing over many Particulars, I ſhall only give one Inſtance more, becauſe it may be a good Caution to ſome Perſons, that theſe Papers may probably fall into the Hands of; and that is, the Danger of ſwallowing *Plumb-ſtones*,

Prune-

bled to make, to diſcharge the peccant Humours, to correct the morbifick Matter; and, in a Word, to ſet all Things right again? But here we had beſt take the Advice of a learned Phyſican in the Caſe: "The Body (ſaith he) is ſo contrived, as to be "well enough ſecured againſt the Mutations in the "Air, and the leſſer Errors we daily run upon; "did we not in the Exceſſes of Eating, Drinking, "Thinking, Loving, Hating, or ſome other Folly "let in the Enemy, or lay violent Hands upon our "ſelves. Nor is the Body fitted only to prevent, "but alſo to cure, or mitigate Diſeaſes, when by "theſe Follies brought upon us. In moſt Wounds, "if kept clean and from the Air,—the Fleſh will "glew together with its own native Balm. Bro-"ken Bones are cemented with the *Callus*, which "themſelves help to make." And ſo he goes on with ample Inſtances in this Matter, too many to be here ſpecified *(f)*. Among which he inſtanceth in the Diſtempers of our Bodies, ſhewing, That even many of them are highly ſerviceable to the Diſcharge of malignant Humours, and preventing greater Evils.

And no leſs kind than admirable is this Contrivance of Man's Body, that even its Diſtempers ſhould many Times be its Cure *(g)*; that when the Enemy

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Prune-ſtones, &c. Sir *Francis Butler*'s Lady had many *Prune-ſtones* that made way through an Abſceſs near her Navel. *Philoſoph. Tranſ.* N° 265, where are other ſuch like Examples. More alſo may be found in N° 282, 304, *&c.* And at this Day, a young Man, living not far off me, laboureth under very troubleſome and dangerous Symptoms, from the Stones of *Sloes* and *Bullace*, which he ſwallowed eight or ten Years ago.

(f) Grew's *Coſmol.* ſect. 28, 29.

(g) Nor are Diſeaſes themſelves uſeleſs: For the Blood in a Fever, if well governed, like Wine upon the Fret, diſchargeth itſelf of all heterogeneous Mixtures; and Nature, the Diſeaſe, and Remedies,

Enemy lies lurking within to deſtroy us, there ſhould be ſuch a Reluctancy, and all Nature excited with its utmoſt Vigour to expel him thence. To which Purpoſe, even Pain itſelf is of great and excellent Uſe, not only in giving us Notice of the Preſence of the Enemy, but by exciting us to uſe our utmoſt Diligence and Skill to root out ſo troubleſome and deſtructive a Companion.

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dies, clean all the Rooms of the Houſe; whereby that which threatens Death, tends, in Concluſion, to the prolonging of Life. Grew, ubi ſupr. ſect. 52.

And as Diſeaſes miniſter ſometimes to Health: ſo to other good Uſes in the Body, ſuch as quickning the Senſes: Of which take theſe Inſtances relating to the Hearing and Sight.

A very ingenious Phyſician falling into an old Kind of Fever, had his Senſe of Hearing thereby made ſo very nice and tender, that he very plainly heard ſoft Whiſpers, that were made at a conſiderable Diſtance off; and which were not in the leaſt perceived by the By-ſtanders, nor would have been by him before his Sickneſs.

A Gentleman of eminent Parts and Note, during a Diſtemper he had in his Eyes, had his Organs of Sight brought to be ſo tender, that both his Friends, and himſelf have aſſured me, That when he waked in the Night, he could for a while plainly ſee and diſtinguiſh Colours, as well as other Objects, diſcernable by the Eye, as was more than once tried. Boyl. deter. Nat. of Effluv. chap. iv.

Daniel Fraſer—*continued Deaf and Dumb from his Birth, till the 17th Year of his Age—After his Recovery from a Fever, he perceived a Motion in his Brain, which was very uneaſy to him; and afterwards he began to hear, and in Proceſs of Time, to underſtand Speech,* &c. Vid. Philoſ. Tranſ. N° 312.

CHAP. VIII.

Of the Conſent between the Parts of Man's Body.

IT is an admirable Proviſion the merciful Creator hath made for the Good of Man's Body, by the Conſent and Harmony between the Parts thereof: Of which let us take St. *Paul*'s Deſcription, in 1 *Cor.* xii. 8. *But now hath God ſet the Members, every one of them in the Body, as it hath pleaſed him.* And ver. 21. *The Eye cannot ſay unto the Hand, I have no need of thee: Nor, again, the Head to the Feet, I have no need of you.* But ſuch is the Conſent of all the Parts, or, as the Apoſtle wordeth it, *God hath ſo tempered the Body together, that the Members ſhould have the ſame Care one for another*, ver 25. So that *whether one Member ſuffer, all the Members ſuffer with it; or one Member be honoured,* (or affected with any Good,) *all the Members rejoice* [and ſympathize] *with it*, ver. 26.

This mutual Accord, Conſent, and Sympathy of the Members, there is no Reaſon to doubt *(a)*, is made by the Commerce of the Nerves *(b)*, and

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(a) See *Book* IV. *Chap.* 8.

(b) Tria propoſita ipſi Naturæ in Nervorum diſtributione fuerunt. 1. *Ut ſenſoriis inſtrumentis Senſum impertiret.* 2. *Ut motoriis Motum.* 3. *Ut omnibus aliis* [*partibus*] *daret ut quæ ſi dolorem adferrent, dignoſcerent.* And afterwards, *Si quis in diſſectionibus ſpectavit, conſideravitque juſtène, an ſecus Natura Nervos non eâdem menſurâ omnibus partibus diſtribuerit, ſed aliis quidem liberaliùs, aliis verò parciùs, eadem cum Hippocrate, velit nolit, de Naturâ omnino pronunciabit, quod ea ſcilicet ſagax, juſta, artificioſa, animaliumque provida eſt.* Galen de Uſu Part. lib. v. cap. 9.

their artificial Poſitions, and curious Ramifications throughout the whole Body, which is admirable and incomparable, and might deſerve a Place in this Survey, as greatly, and manifeſtly ſetting forth the Wiſdom and Benignity of the great Creator; but that to give a Deſcription thereof from the Origin of the Nerves, in the *Brain*, the *Cerebellum* and *Spine*, and ſo through every Part of the Body, would be tedious, and intrench too much upon the Anatomiſt's Province: And therefore one Inſtance ſhall ſuffice for a Sample of the Whole; and that ſhall be, (what was promiſed before) *(c)*, the great Sympathy occaſioned by the *fifth Pair* of Nerves; which I chuſe to inſtance in, rather than the *Par Vagum*, or any other of the Nerves; becauſe although we may have leſs Variety of noble Contrivance and Art, than in that Pair; yet we ſhall find enough for our Purpoſe, and which may be diſpatched in fewer Words. Now this *fifth Conjugation* of *Nerves* is branched to the Ball, the Muſcles, and Glands of the Eye; to the Ear; to the Jaws, the Gums, and Teeth; to the Muſcles of the Lips *(d)*; to the Tonſils, the Palate, the Tongue, and the Parts of the Mouth; to the *Præcordia* alſo, in ſome Meaſure, by inoſculating with one of its Nerves; and laſtly, to the Muſcles of the Face, particularly the Cheeks, whoſe ſanguiferous Veſſels it twiſts about.

(c) Book IV. *Chap.* 5.

(d) Dr. *Willis* gives the Reaſon, *Cur mutua Amaſiorum oſcula labiis impreſſa, tum præcordia, tum genitalia afficiendo, amorem ac libidinem tam facile irritant*, to be from the Conſent of thoſe Parts, by the Branches of this fifth Pair. *Nerv. Diſcr.* cap. 22.

And Dr. *Sachs* judges it to be from the Conſent of the *Labia Oris cum Labiis Uteri*, that in *April* 1669, a certain breeding Lady, being affrighted with ſeeing one that had ſcabby Lips, which they told her were occaſioned by a peſtilential Fever, had ſuch like Puſtules break out in the *Labia Uteri*. *Ephem. Germ. T.* i. *Obſ.* 20.

From hence it comes to paſs, that there is a great Conſent and Sympathy (*e*) between theſe Parts; ſo that a guſtable Thing ſeen or ſmelt excites the Appetite, and affects the Glands and Parts of the Mouth; that a Thing ſeen or heard, that is ſhameful, affects the Cheeks with modeſt Bluſhes; but, on the contrary, if it pleaſes and tickles the Fancy, that it affects the *Præcordia*, and Muſcles of the Mouth and Face with Laughter; but a Thing cauſing Sadneſs and Melancholy, doth accordingly exert itſelf upon the *Præcordia*, and demonſtrate itſelf by cauſing the Glands of the Eyes to emit Tears (*f*), and the Muſcles of the Face to put on the ſorrowful Aſpect of Crying. Hence alſo that torvous ſour Look produced by Anger and Hatred: And that gay and pleaſing Countenance accompanying Love and Hope. And in ſhort, it is by Means of this Communication of the Nerves, that whatever affects the Soul is demonſtrated, (whether we will or no,) by a conſentaneous Diſpoſition of the *Præcordia* within, and a ſuitable Configuration of the Muſcles and Parts of the Face without. And an admirable Contrivance of the great GOD of *Nature* this is; That as a Face is given to Man, and as *Pliny* ſaith (*g*), to Man alone of all Creatures; ſo it ſhould be, (as he obſerves,) *the Index of Sorrow and Chearfulneſs, of Compaſſion and Severity. In its aſcending Part is the Brow, and therein a Part of the Mind too. Therewith we deny, therewith we conſent. With this it is we ſhew*

(*e*) Conſult *Willis ubi ſuprà.*

(*f*) Tears ſerve not only to moiſten the Eye, to clean and brighten the *Cornea*, and to expreſs our Grief; but alſo to alleviate it, according to that of *Ulyſſes* to *Andromache*, in *Seneca's Troas*, ver. 762.

Tempus moramque dabimus, arbitrio tuo
Implere lacrymis: Fletus ærumnas levat.

(*g*) *Plin.* Nat. Hiſt. lib. xi. cap. 37.

our Pride, which hath its Source in another Place; but here its Seat: In the Heart it hath its Birth; but here it abides and dwells; and that becauſe it could find no other Part throughout the Body higher, or more craggy (b), where it might reſide alone.

Thus I have diſpatched what I ſhall remark concerning the Soul and Body of Man. There are divers other Things, which well deſerve a Place in this Survey; and theſe that I have taken Notice of, deſerved to have been enlarged upon: But what hath been ſaid, may ſuffice for a Taſte and Sample of this admirable Piece of God's Handywork; at leaſt ſerve as a Supplement to what others have ſaid before me. For which Reaſon I have endeavoured to ſay as little wittingly as I could, of what they have taken Notice of, except where the Thread of my Diſcourſe laid a Neceſſity upon me.

(b) Nihil altius ſimul abruptiuſque invenit.

CHAP. IX.

Of the Variety of Mens Faces, Voices, and Hand-Writing.

HERE I would have put an End to my Obſervations relating to Man; but that there are three Things ſo expreſly declaring the Divine Management and Concurrence, that I ſhall juſt mention them, although taken Notice of more amply by others; and that is, The great Variety throughout the World, of Men's Faces *(a)*, Voices,

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(a) If the Reader hath a Mind to ſee Examples of Men's Likeneſs, he may conſult *Valer. Maximus*, lib. ix. cap 14. concerning

Voices *(b)*, and Hand-Writing. Had Man's Body been made according to any of the atheiſtical Schemes, or any other Method than that of the infinite Lord of the World, this wiſe Variety would never have been: But Men's Faces would have been caſt in the ſame, or not a very different Mould; their Organs of Speech would have ſounded the ſame, or not ſo great a Variety of Notes; and the ſame Structure of Muſcles and Nerves, would have given the Hand the ſame Direction in Writing. And in this Caſe, what Confuſion, what Diſturbance, what Miſchiefs, would the World eternally have lain under? No Security could have been to our Perſons; no Certainty, no Enjoyment of our Poſſeſſions *(c)*; no Juſtice between Man and Man; no Diſtinction between

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concerning the Likeneſs of *Pompey* the Great, and *Vibius*, and *Publicius Libertinus*; as alſo of *Pompey* the Father, who got the Name of *Coquus*, he being like *Menogenes* the Cook; with divers others.

(b) As the Difference of Tone makes a Difference between every Man's Voice, of the ſame Country, yea, Family, ſo a different Dialect and Pronunciation, differs Perſons of divers Countries, yea, Perſons of one and the ſame Country, ſpeaking the ſame Language: Thus in *Greece*, there were the *Ionick*, *Dorick*, *Attick*, and *Æolick* Dialects. So in *Great Britain*, beſides the grand Diverſity of *Engliſh* and *Scotch*, the different Counties vary very much in their Pronunciation, Accent, and Tone, although all one and the ſame Language. And the Way of the *Gileadites* proving the *Ephraimites*, *Judg*. xii. 6. by the Pronunciation of *Shibboleth*, with a *Schin*, or *Sibboleth* with a *Samech*, is well known. So *à Lapide* ſaith, the *Flemings* prove whether a Man be a *Frenchman* or not, by bidding him pronounce *Acht en tachtenticht*; which they pronounce, *Act en tactentic*, by reaſon they cannot pronounce the Aſpirate *h*.

(c) Regi Antiocho unus ex æqualibus — nomine Artemon, perquam ſimilis fuiſſe traditur. Quem Laodice, uxor Antiochi, interfecto viro, diſſimulandi ſceleris gratiâ, in lectulo perinde quaſi ipſum Regem agrum collocavit. Admiſſumque univerſum populum, & ſermone ejus & vultu conſimili fefellit: crediderunique homines ab Antiocho moriente Laodicen & natos ejus ſibi commendari. Valer. Max. ib.

Good and Bad, between Friends and Foes, between Father and Child, Huſband and Wife, Male or Female; but all would have been turned topſey-turvey, by being expoſed to the Malice of the Envious and Ill-natured, to the Fraud and Violence of Knaves and Robbers, to the Forgeries of the crafty Cheat, to the Luſts of the Effeminate and Debauched, and what not! Our Courts of Juſtice *(d)* can abundantly teſtify the dire Effects of miſtaking Men's Faces, of counterfeiting their Hands, and forging Writings. But now, as the infinitely wiſe Creator and Ruler hath ordered the Matter, every Man's Face can diſtinguiſh him in the Light, and his Voice in the Dark; his Hand-writing can ſpeak for him though abſent, and be his Witneſs, and ſecure his Contracts in future Generations. A manifeſt, as well as admirable Indication of the divine Superintendence and Management *(e)*.

(d) Quid Trebellius Calca! quàm aſſeveranter ſeſe Clodium tulit! & quidem dum de bonis ejus contendit, in centumvirale judicium adeò favorabilis deſcendit, ut vix juſtis & æquis ſententiis conſternatio populi ullum relinqueret locum. In illâ tamen quæſtione neque calumniæ petitoris, neque violentiæ plebis judicantium religio ceſſit. Val. Max. ib. cap. 15.

(e) To the foregoing Inſtances of Divine Management, with relation to the political State of Man, I ſhall add another Thing, that I confeſs hath always ſeemed to me ſomewhat odd, but very providential; and that is, the Value that Mankind, at leaſt the civilized Part of them, have in all Ages put upon Gems, and the purer finer Metals, Gold and Silver; ſo as to think them equivalent unto, and exchange them for Things of the greateſt Uſe for Food, Cloathing, and all other Neceſſaries and Conveniences of Life. Whereas thoſe Things themſelves are of very little, if any, Uſe in Phyſic, Food, Building, or Cloathing, otherwiſe than for Ornament, or to miniſter to Luxury; as *Suetonius* tells us of *Nero*, who fiſhed with a Net gilt with Gold, and ſhod his Mules with Silver; but his Wife *Poppæa* ſhod her Horſes with Gold. *Vit. Ner.* cap. xxx. *Plin. Nat. Hiſt.* lib. xxxiii. cap. 11. So the ſame *Suetonius* tells us, *Jul. Cæſar* lay in a Bed of Gold, and rode in a Silver Chariot. But *Heliogabalus* rode in one of Gold, and

had his Cloſe-ſtool-Pans of the ſame Metal. And *Pliny* ſaith, *Vaſa Coquinaria ex argento Calvus Orator fieri queritur. Ibid.* Neither are thoſe precious Things of greater Uſe to the making of Veſſels, and Utenſils, (unleſs ſome little Niceties and Curioſities,) by means of their Beauty, Imperdibility, and Ductility. Of which laſt, the great Mr. *Boyle* hath, among others, theſe two Inſtances, in his *Eſſay about the Subtilty of Effluviums*, chap. ii. *Silver, whoſe Ductility, and Tractility, are very much inferior to thoſe of Gold, was, by my procuring, drawn out to ſo ſlender a Wire, that — a ſingle Grain of it amounted to twenty-ſeven Feet.* As to Gold, he demonſtrates it poſſible to extend an Ounce thereof to reach to 777600 Feet, or 155 Miles and an half, yea, to an incredibly greater Length.

And as to Gems, the very Stories that are told of their prodigious Virtues, are an Argument, that they have very little, or none, more than other hard Stones. That a *Diamond* ſhould diſcover whether a Woman be true or falſe to her Huſband's Bed; cauſe Love between Man and Wife; ſecure againſt Witchcraft, Plague, and Poiſons; that the *Ruby* ſhould diſpoſe to Cheerfulneſs, cauſe pleaſant Dreams, change its Colour againſt a Misfortune befalling, &c. that the *Sapphire* ſhould grow foul, and loſe its Beauty, when worn by one that is Leacherous; that the *Emerald* ſhould fly to pieces, if it touch the Skin of any unchaſte Perſon in the Act of Uncleanneſs: that the *Chryſolite* ſhould loſe its Colour, if Poiſon be on the Table, and recover it again when the Poiſon is off; and, to name no more, that the *Turcoiſe* (and the ſame is ſaid of a Gold Ring,) ſhould ſtrike the Hour when hung over a drinking Glaſs, and much more to the ſame Purpoſe: All theſe, and many other ſuch fabulous Stories, I ſay, of Gems, are great Arguments, that their Virtue is equivalent to their Value. Of theſe, and other Virtues, conſult *Worm* in his *Muſeum*, lib. i. chap. 17, &c.

But as to *Gems* changing their Colour, there may be ſomewhat of Truth in that, particularly in the *Turcoiſe* laſt mentioned. Mr. *Boyle* obſerved the Spots in a *Turcoiſe*, to ſhift their Place from one Part to another, by gentle Degrees. So did the Cloud in an *Agate*-Handle of a Knife. A *Diamond* he wore on his Finger, he obſerved to be more illuſtrious at ſome times than others; which a curious Lady told him ſhe had alſo obſerved in hers. So likewiſe a rich *Ruby* did the ſame. *Boyle* of *Abſol. Reſt in Bodies.*

CHAP. X.

The Concluſion of the Survey of Man.

AND now having taken a View of *Man*, and finding every Part of him, every Thing relating to him contrived, and made in the very beſt Manner; his Body fitted up with the utmoſt Foreſight, Art, and Care; and this Body, (to the great Honour, Privilege, and Benefit of Man,) poſſeſſed by a Divine Part, the *Soul*, a Subſtance made as it were on Purpoſe to contemplate the Works of GOD, and glorify the great Creator; and ſince this Soul can diſcern, think, reaſon, and ſpeak; What can we conclude upon the whole Matter, but that we lie under all the Obligations of Duty and Gratitude, to be thankful and obedient to, and to ſet forth the Glories of our great Creator, and noble Benefactor! And what ungrateful Wretches are we, how much worſe than the poor Irrationals, if we do not employ the utmoſt Power of our Tongue, and all our Members, and all the Faculties of our Souls, in the Praiſes of GOD! But above all, ſhould we, who have the Benefit of thoſe glorious Acts and Contrivances of the Creator, be ſuch wicked, ſuch baſe, ſuch worſe than brutal Fools, to deny the Creator (*a*), in ſome of his nobleſt Works?

Should

(*a*) It was a pious, as well as juſt Concluſion, the ingenious *Laurence Bellini* makes of his *Opuſculum de Motu Cordis*, in theſe Words: *De Motu Cordis iſthæc. Quæ equidem omnia, ſi à rudi intelligentiâ Hominis tantum conſilii, tantum ratiocinii,*

tantum

Should we ſo abuſe our Reaſon, yea, our very Senſes; ſhould we be ſo beſotted by the Devil, and blinded by our Luſts, as to attribute one of the beſt contrived Pieces of Workmanſhip to blind Chance, or unguided Matter and Motion, or any other ſuch ſottiſh, wretched, atheiſtical Stuff? which we never ſaw, nor ever heard made any one Being (b) in any Age ſince the Creation? No, No! But like wiſe and unprejudiced Men, let us with *David*

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tantum peritiæ mille rerum, tantum ſcientiarum exigunt, ad hoc, ut inveniantur, ſeu ad hoc, ut percipiantur poſtquam facta ſunt; illum, cujus operâ, fabrefacta ſunt hæc ſingula, tam vani erimus atque inanes, ut exiſtimemus eſſe conſilii impotem, rationis expertem, imperitum, aut ignarum omnium rerum? Quantum ad me attinet, nolim eſſe Rationis compos, ſi tantum inſudandum mihi eſſet ad conſequendum intelligentiam earum rerum, quas fabrefaceret neſcio quæ Vis, quæ nihil intelligeret eorum quæ fabrefaceret; mihi etenim viderer eſſe vile quiddam, atque ridiculum, qui vellem totam ætatem meam, ſanitatem, & quicquid humanum eſt deterere, nihil curare quicquid eſt jucunditatum, quicquid lætitiarum, quicquid commodorum; non divitias, non dignitates: non pœnas etiam, & vitam ipſam, ut gloriari poſſem poſtremò inveniſſe unum, aut alterum, & fortaſſe me inveniſſe quidem ex iis innumeris, quæ produxiſſet, neſcio quis ille, qui ſine labore, ſine curâ, nihil cogitans, nihil cognoſcens, non unam aut alteram rem, neque dubie, ſed certò produxiſſet innumeras innumerabilitates rerum in hoc tam immenſo ſpatio corporum, ex quibus totus Mundus compingitur. Ah Deum immortalem! Video præſens numen tuum in hiſce tam prodigioſis Generationis initiis, & in altiſſimâ eorum contemplatione defixus, neſcio quo æſtro admirationis conciter, & quaſi divine furens cohiberi me minimè poſſum quin exclamem.

Magnus Dominus! Magnus Fabricator Hominum Deus! Magnus atque Admirabilis! Conditor rerum Deus quàm Magnus es! Bellin. de Mot. Cord. fin.

(b) *Hoc* [*i. e.* mundum effici ornatiſſimum, & pulcherrimum ex concurſione fortuitâ] *qui exiſtimat fieri potuiſſe, non intelligo cur non idem putet, ſi innumerabiles unius, & viginti formæ literarum, vel aureæ, vel qualeſlibet, aliquo conjiciantur, poſſe ex his in terram excuſſis annales Ennii ut deinceps legi poſſint, effici, &c. —Quod ſi Mundum efficere poteſt concurſus Atomorum, cur porticum, cur templum, cur domum, cur urbem non poteſt? Quæ ſunt minus operoſa, & multò quidem faciliora.* Cic. de Nat. Deor. lib. ii. cap. 37.

ſay, *Pſalm* cxxxix. 14. (with which I conclude,) *I will praiſe thee, for I am fearfully and wonderfully made; marvellous are thy Works, and that my Soul knoweth right well.*

Having thus made what (conſidering the Copiouſneſs and Excellence of the Subject,) may be called a very brief Survey of *Man*, and ſeen ſuch admirable Marks of the Divine Deſign and Art; let us next take a tranſient View of the other inferior Creatures; and begin with Quadrupeds.

BOOK VI.

A SURVEY of QUADRUPEDS.

CHAP. I.

Of their Prone Poſture.

IN taking a View of this Part of the Animal World, ſo far as the Structure of their Bodies is conformable to that of Man, I ſhall paſs them by, and only take Notice of ſome Peculiarities in them, which are plain Indications of Deſign, and the Divine Superintendence and Management. And 1. The moſt viſible apparent Variation is the *Prone Poſture of their Body:* Concerning which, I ſhall take Notice only of two Things, the Parts miniſtring thereto, and the Uſe and Benefit thereof.

I. As for the Parts, it is obſervable, That in all theſe Creatures, the Legs are made exactly conformable to this Poſture, as thoſe in Man are to his erect Poſture: And what is farther obſervable alſo, is, that the Legs and Feet are always admirably ſuited to the Motion and Exerciſes of each Animal: In ſome they are made for Strength only, to ſupport a vaſt, unwieldy Body (a); in others they are made for Agility and Swiftneſs (b); in ſome they are made for only Walking and Running; in others for that, and Swimming too (c); in others for Walking and Digging (d): and in others for Walking and Flying (e); In ſome they are made more lax and weak, for the plainer Lands; in others rigid, ſtiff, and leſs flexible (f), for traverſing

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(a) The Elephant being a Creature of prodigious Weight, the largeſt of all Animals, *Pliny* ſaith, hath its Legs accordingly made of an immenſe Strength, like Pillars, rather than Legs.

(b) Deer, Hares, and other Creatures, remarkable for Swiftneſs, have their Legs accordingly ſlender, but withal ſtrong, and every Way adapted to their Swiftneſs.

(c) Thus the Feet of the *Otter* are made, the Toes being all conjoined with Membranes, as the Feet of Geeſe and Ducks are. And in Swimming, it is obſervable, That when the Foot goes forward in the Water, the Toes are cloſe; but when backward, they are ſpread out, whereby they more forcibly ſtrike the Water, and drive themſelves forward. The ſame may be obſerved alſo in Ducks and Geeſe, &c.

Of the *Caſtor* or *Beaver*, the *French* Academiſts ſay, *The Structure of the Feet was very extraordinary, and ſufficiently demonſtrated, that Nature hath deſigned this Animal to live in the Water, as well as upon Land. For although it had four Feet, like Terreſtrial Animals, yet the hindmoſt ſeemed more proper to ſwim than walk with, the five Toes of which they were compoſed, being joined together like thoſe of a Gooſe by a Membrane, which ſerves this Animal to ſwim with. But the fore Ones were made otherwiſe; for there was no Membrane which held thoſe Toes joined together: And this was requiſite, for the Conveniency of this Animal, which uſeth them as Hands like a Squirrel, when he eats.* Memoirs for a natural Hiſtory of Animals, *pag.* 84.

(d) The *Mole*'s Feet are a remarkable Inſtance.

(e) The Wings of the *Bat* are a prodigious Deviation from Nature's ordinary Way. So it is in the *Virginian Squirrel,* whoſe Skin is extended between the Fore-legs and its Body.

(f) Of the Legs of the *Elk*, the *French* Academiſts ſay, *Although ſome Authors report, That there are* Elks *in* Muſcovia, *whoſe Legs are jointleſs; there is great Probability, that this Opinion is founded on what is reported of thoſe* Elks *of* Muſcovia, as

well

ſing the Ice, and dangerous Precipices of the high Mountains *(g)*; in ſome they are ſhod with rough and hard Hoofs, ſome whole, ſome cleft; in others with only a callous Skin. In which latter, it is obſervable that the Feet are compoſed of Toes, ſome ſhort for bare-going; ſome long to ſupply the Place of a Hand *(h)*; ſome armed with long and ſtrong Talons to catch, hold, and tear the Prey; ſome fenced only with ſhort Nails, to confirm the Steps in Running and Walking.

II. As the Poſture of Man's Body is the fitteſt for a Rational Animal, ſo is the Prone Poſture of *Quadrupeds* the moſt uſeful and beneficial to themſelves, as alſo moſt ſerviceable to Man. For they are hereby better made for their gathering their Food, to purſue their Prey, to leap, to climb, to ſwim, to guard themſelves againſt their Enemies; and, in a Word, to do whatever may be of principal Uſe to themſelves; as alſo they are hereby rendered more uſeful and ſerviceable to Man, for carrying his Burdens, for tilling his Ground; yea, even for his Sports and Diverſions.

And now I might here add a Survey of the excellent Contrivances of the Parts miniſtring to this

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well as *of* Cæſar's Alce, *and* Pliny's Machlis, *that they have Legs ſo ſtiff and inflexible, that they do run on Ice without ſlipping; which is a Way that is reported that they have to ſave themſelves from the Wolves*, &c. Ibid. p. 108.

(g) The common tame *Goat* (whoſe Habitation is generally on Mountains and Rocks, and who delighteth to walk on the Tops of Pales, Houſes, *&c.* and to take great and ſeemingly dangerous Leaps) I have obſerved, hath the Joints of the Legs very ſtiff and ſtrong, the Hoof hollow underneath, and its Edges ſharp. The like, I doubt not, is to be found in the *Wild Goat*, conſidering what Dr. *Scheuchzer* hath ſaid of its climbing the moſt dangerous Craggs of the *Alps*, and the Manner of their hunting it. *Vid. Iter. Alpin.* 3. *p.* 9.

(h) Thus in *Apes* and *Monkeys*, in the *Beaver* before, and divers others.

Poſture of the four-footed Animals, the admirable Structure of the Bones *(i)*, the Joints and Muſcles, their various Sizes and Strength; their commodious Lodgment and Situation, the nice Æquipoiſe of the Body, with a great deal more to the ſame Purpoſe. But I ſhould be tedious to inſiſt minutely upon ſuch Particulars; and beſides, I have given a Touch upon theſe Kinds of Things, when I ſpake of Man.

Paſſing by therefore many Things of this Kind, that might deſerve Remark, I ſhall only conſider ſome of the Parts of the *Quadrupeds*, differing from what is found in Man *(k)*, and which are manifeſt Works of Deſign.

(i) It is a ſingular Proviſion Nature hath made for the Strength of the *Lion*, if that be true, which *Galen* ſaith is reported of its Bones being not hollow (as in other Animals) but ſolid: Which Report he thus far confirms, that moſt of the Bones are ſo; and that thoſe in the Legs, and ſome other Parts, have only a ſmall and obſcure Cavity in them. *Vid. Galen. de Uſ. Part.* lib. xi. cap. 18.

(k) Theſe Sorts of Differences in the Mechaniſm of Animals, upon the Score of the Poſition of their Bodies, occur ſo often, that it would be no mean Service to Anatomy—if any one would give us a Hiſtory of thoſe Variations of the Parts of Animals, which ſpring from the different Poſtures of their Bodies. Drake Anat. Vol. i. Book i. Chap. 17.

CHAP.

CHAP. II.

Of the Heads of Quadrupeds.

IT is remarkable that in Man, the Head is of one ſingular Form; in the four-footed Race, as various as their Species. In ſome, ſquare and large, ſuitable to their ſlow Motion, Food, and Abode; in others leſs, ſlender and ſharp, agreeable to their ſwifter Motion, or to make their way to their Food (*a*), or Habitation under Ground (*b*). But paſſing by a great many Obſervations that might be made of this Kind, I ſhall ſtop a little at the Brain, as the moſt conſiderable Part of this Part of the Body, being the great Inſtrument of Life and Motion in *Quadrupeds*, as it is in Man of that, as alſo in all Probability the chief Seat of his immortal Soul. And accordingly it is a remarkable Difference, that in Man the Brain is large, affording Subſtance, and Room for ſo noble a Gueſt; whereas in *Quadrupeds*, it is but ſmall. And another Thing, no leſs remarkable, is the Situation of the *Cerebrum* and *Cerebellum*,

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(*a*) Thus *Swine*, for Inſtance, who dig in the Earth for Roots, and other Food, have their Neck, and all Parts of their Head very well adapted to that Service. Their Neck ſhort, brawny, and ſtrong; their Eyes ſet pretty high out of the Way; their Snout long; their Noſe callous and ſtrong; and their Senſe of Smelling very accurate, to hunt out and diſtinguiſh their Food in Mud, under Ground, and other the like Places where it lies concealed.

(*b*) What hath been ſaid of *Swine* is no leſs, rather more remarkable in the *Mole*, whoſe Neck, Noſe, Eyes and Ears are all fitted, in the niceſt Manner, to its ſubterraneous Way of Life.

or the greater or leſſer Brain, which I ſhall give in the Words of one of the moſt exact Anatomiſts we have of that Part *(c)*: "Since, ſaith he, God hath "given to Man a lofty Countenance, to behold the "Heavens, and hath alſo ſeated an immortal Soul "in the Brain, capable of the Contemplation of "heavenly Things; therefore, as his Face is erect, "ſo the Brain is ſet in an higher Place, namely, "above the *Cerebellum*, and all the Senſories. But "in Brutes, whoſe Face is prone towards the "Earth, and whoſe Brain is capable of Speculation, "the *Cerebellum*, (whoſe Buſineſs it is to miniſter to "the Actions and Functions of the *Præcordia*, the "principal Office in thoſe Creatures) in them is ſi-"tuated in the higher place, and the *Cerebrum* "lower. Alſo ſome of the Organs of Senſe, as the "Ears and Eyes, are placed, if not above the *Ce-"rebrum*, yet at leaſt equal thereto."

Another Convenience in this Poſition of the *Cerebrum* and *Cerebellum*, the laſt ingenious Anatomiſt *(d)* tells us is this, "In the Head of Man, "ſaith he, the Baſe of the *Brain* and *Cerebell*, yea, "of the whole Skull, is ſet parallel to the Hori-"zon; by which Means there is the leſs Danger "of the two Brains joggling, or ſlipping out of "their Place. But in *Quadrupeds*, whoſe Head "hangs down, the Baſe of the Skull makes a right "Angle with the Horizon, by which Means the "Brain is undermoſt, and the *Cerebell* uppermoſt; "ſo that one would be apt to imagine the *Cere-"bell* ſhould not be ſteady, but joggle out of its "Place." To remedy which Inconvenience, he tells us, "And leſt the frequent Concuſſions of "the *Cerebell* ſhould cauſe a Fainting, or diſorder-

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(c) *Willis Cereb. Anat.* cap. 6. *Cumque huic Deus os ſublime dederit, &c.*

(d) Id. paulo poſt. *In capite humano Cerebri & Cerebelli,* &c.

“ ly Motion of the Spirits about the *Præcordia*,
“ therefore, by the Artifice of Nature, ſufficient
“ Proviſion is made in all, by the *Dura Meninx*
“ cloſely encompaſſing the *Cerebellum*; beſides which,
“ it is (in ſome) guarded with a ſtrong bony Fence;
“ and in others, as the Hare, the Coney, and ſuch
“ leſſer *Quadrupeds*, a Part of the *Cerebell* is on each
“ Side fenced with the *Os Petroſum*: So that by
“ this double Stay, its whole Maſs is firmly con-
“ tained within the Skull.”

Beſides theſe Peculiarities, I might take notice of divers other Things no leſs remarkable, as the *Nictitating Membrane* of the Eye (e), the different Paſſages of the *Carotid Arteries* (f) through the Skull, their Branching into the *Rete Mirabile* (g),
the

(e) See *Book* IV. *Chap.* 2. *Note* (kk).

(f) *Arteria Carotis Aliquanto poſterius in homine quàm in alio quovis animali, Calvariam ingreditur, ſcil. juxta illud foramen, per quod ſinus lateralis in Venam jugularem deſiturus cranio elabitur; nam in cæteris hæc arteria ſub extremitate, ſeu proceſſu acuto oſſis petroſi, inter cranium emergit: verùm in capite humano, eadem, ambage longiori circumducta (ut ſanguinis torrens, priuſquàm ad cerebri oram appellit, fracto impetu, leniùs & placidius fluat) prope ſpecum ab ingreſſu ſinûs lateralis factum, Calvariæ baſin attingit; —& in majorem cautelam, tunicâ inſuper aſcititiâ craſſiore inveſtitur.* And ſo he goes on to ſhew the Conveniency of this Guard the Artery hath, and its Paſſage to the Brain, and then ſaith, *Si hujuſmodi conformationis ratio inquiritur, facilè occurrit, in capite humano, ubi generoſi affectus & magni animorum impetus ac ardores excitantur, ſanguinis in Cerebri oras appulſum debere eſſe liberum & expeditum, &c. Atque hoc quidem reſpectu differt Homo à pleriſque Brutis, quibus, Arteria in mille ſurculos diviſa, ne ſanguinem pleniore alveo, aut citatiore, quàm par eſt, curſu, ad cerebrum evehat, Plexus Retiformes conſtituit, quibus nempe efficitur, ut ſanguis tardo admodum, lenique & æquabili fere ſtillicidio, in cerebrum illabatur.* And then he goes on to give a farther Account of this *Artery*, and the *Rete mirabile*, in divers Creatures. *Willis*, ibid. cap. 8.

(g) *Galen* thinks the *Rete Mirabile* is for concocting and elaborating the Animal Spirits, as the *Epididymides*, [the Convolutions κιρσοειδὴς ἕλιξ] are for elaborating the Seed, the different Magnitude of the *Nates*, and ſome other Parts of the Brain in Beaſts, quite different from what it is in Man: But the Touches already given, may be Inſtances ſufficient to prevent my being tedious in inlarging upon theſe admirable Works of God.

De Uſ. Part. lib. ix. cap. 4. This *Rete* is much more conſpicuous in Beaſts than Man; and, as Dr. *Willis* well judges, ſerves, 1. To bridle the too rapid Incurſions of the Blood into the Brain of thoſe Creatures, whoſe Heads hang down much. 2. To ſeparate ſome of the ſuperfluous ſerous Parts of the Blood, and ſend them to the Salival Glands, before the Blood enters the Brain of thoſe Animals, whoſe Blood is naturally of a watery Conſtitution. 3. To obviate any Obſtructions that may happen in the Arteries, by giving a free Paſſage through other Veſſels, when ſome are ſtopped.

In *Quadrupeds*, as the *Carotid Arteries* are branched into the *Rete Mirabile*, for the bridling the too rapid Current of Blood into the Brain; ſo the *Vertebral Arteries* are, near their Entrance into the Skull, bent into an acuter Angle than in Man, which is a Wiſe Proviſion for the ſame Purpoſe.

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CHAP. III.

Of the Necks of Quadrupeds.

FROM the Head paſs we to the Neck, no principal Part of the Body, but yet a good Inſtance of the Creator's Wiſdom and Deſign, inaſmuch as in Man it is ſhort, agreeable to the Erection of his Body; but in the Four-footed Tribe it is long, anſwerable to the Length of the Legs (*a*), and

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(*a*) It is very remarkable, that in all the Species of *Quadrupeds*, this Equality holds, except only the *Elephant*; and that there and in ſome of theſe long, and leſs ſtrong, ſerving to carry the Mouth to the Ground; in others ſhorter, brawny, and ſtrong, ſerving to dig, and heave up great Burdens *(b)*.

But that which deſerves eſpecial Remark is, that peculiar Proviſion made in the Necks of all, or moſt granivorous *Quadrupeds*, for the perpetual holding down their Head in gathering their Food, by that ſtrong, tendinous, and inſenſible *Aponeuroſis*, or Ligament *(c)*, braced from the Head to the Middle of the Back. By which means the Head, although heavy, may be long held down without any Labour, Pain, or Uneaſineſs to the Muſcles of the Neck, that would otherwiſe be wearied by being ſo long put upon the Stretch.

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there ſhould be a ſufficient ſpecial Proviſion made for that Creature, by its *Proboſcis* or *Trunk*. A Member ſo admirably contrived, ſo curiouſly wrought, and with ſo great Agility and Readineſs applied by that unwieldy Creature to all its ſeveral Occaſions, that I take it to be a manifeſt Inſtance of the Creator's Workmanſhip. See its Anatomy in Dr. *A. Moulen's Anat. of the* Elephant, *p.* 33. As alſo in Mr. *Blair*'s Account in *Phil. Tranſ.* N° 326.

Aliorum ea eſt humilitas ut cibum terreſtrem roſtris facilè contingant. Quæ autem altiora ſunt, ut Anſeres, ut Cygni, ut Grues, nt Cameli, adjuvantur proceritate collorum. Manus etiam data Elephantis, qui propter magnitudinem corporis difficiles aditus habebant ad paſtum. Cic. de Nat. Deor. lib. ii. cap. 47.

Quod iis animalibus quæ pedes habent fiſſos in digitos, Collum brevius ſit factum, quàm ut per ipſum Cibum ori admovere queant: iis verò quæ ungulas habent ſolidas, aut bifidas, longius, ut prona atque inclinantia paſci queant. Qui id etiam opus non ſit Artificis utilitatis memoris? Ad hæc quod Grues ac Ciconiæ, cùm crura haberent longiora, ob eam cauſam Roſtrum etiam magnum, & Collum longius habuerint. Piſces autem neque Collum penitus habuere, utpote qui neque Crura habent. Quo pacto non id etiam eſt admirandum? Galen de Uſu Part. lib. xi. cap. 8.

(b) As in *Moles* and *Swine*, in *Chap.* 2. *Note (a)*.

(c) Called the *Whiteleather*, *Packwax*, *Taxwax*, and *Fixfax*.

CHAP. IV.

Of the Stomachs of Quadrupeds.

FROM the Neck, let us deſcend to the *Stomach*, a Part of as abſolute Neceſſity to the Being and Well-being of Animals, ſo is in the ſeveral Species of *Quadrupeds*, ſized, contrived, and made with the utmoſt Variety and Art. *(a)* What Artiſt, what Being, but the infinite Conſervator of the World, could ſo well adapt every Food to all the ſeveral Kinds of thoſe grand Devourers of it! Who could ſo well ſuit their Stomachs to the Reception and Digeſtion thereof; one kind of Stomach to the Carnivorous, another to the Herbaceous Animals; one fitted to digeſt by bare Maſtication; and a whole Set of Stomachs in others, to digeſt with the Help of *Rumination!* Which laſt Act, together with the *Apparatus* for that Service, is ſo peculiar, and withal ſo curious an Artifice of Nature, that it might juſtly deſerve a more

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(a) The peculiar Contrivance and Make of the *Dromedary*'s or *Camel*'s Stomach is very remarkable, which I will give from the *Pariſian Anatomiſts: At the Top of the Second* [of the 4 Ventricles] *there were ſeveral ſquare Holes, which were the Orifices of about* 30 *Cavities, made like Sacks placed between the two Membranes, which do compoſe the Subſtance of this Ventricle: The View of theſe Sacks made us to think that they might well be the Reſervatories, where,* Pliny *ſaith, that Camels do a long Time keep the Water, which they drink in great Abundance —to ſupply the Wants thereof in the dry Deſerts,* &c. Vid. Memoirs, &c. Anat. of Dromedary, p. 39. See alſo *Peyer. Merycol.* lib. ii. cap. 3.

particular Enquiry; but having formerly mentioned it (*b*), and leſt I ſhould be too tedious, I ſhall paſs it by.

(*b*) *Book* IV. *Chap.* 11.

CHAP. V.

Of the Hearts of Quadrupeds.

IN this Part there is a notable Difference found between the Heart of Man and that of Beaſts, concerning the latter of which I might take Notice of the remarkable Conformation of the Hearts of Amphibious *Quadrupeds*, and their Difference from thoſe of Land-Animals, ſome having but one Ventricle (*a*), ſome three (*b*), and ſome but two, (like Land-Animals) but then the *Foramen Ovale* therewith (*c*). All which may be juſtly eſteemed

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(*a*) *Frogs* are generally thought to have but one Ventricle in their Hearts.

(*b*) The *Tortoiſe* hath three Ventricles, as the *Pariſian Academiſts* in their *Memoirs* affirm. *Beſides theſe two Ventricles* [before ſpoken of] *which were in the hinder Part of the Heart, which faceth the Spine, there was,* ſay they, *a third in the Fore-part, inclining a little towards the Right-ſide,* &c. Memoirs, *&c.* p. 259. But Mr. *Buſſiere* charges this as a Miſtake in thoſe ingenious Gentlemen, and aſſerts there is but one Ventricle in the *Tortoiſe*'s Heart. See his Deſcription of the Heart of the *Land-Tortoiſe*, in *Philoſ. Tranſ.* Nº 328.

(*c*) The *Sea Calf* is ſaid by the *French Academiſts*, to have this Proviſion, and their Account of it is this: *Its Heart was round and flat. Its ventricles appeared very large, and its Auricles ſmall. — Underneath the great Aperture, through which the Trunk of the* Vena Cava *conveyed the Blood into the right Ven-*

as wonderful, as they are excellent Proviſions for the Manner of thoſe Animals living. But I ſhall content myſelf with bare Hints of theſe Things, and ſpeak only of two Peculiars more, and that but briefly.

One is, the Situation of the Heart, which in Beaſts is near the Middle of the whole Body; in Man, nearer the Head *(d)*. The Reaſons of which I ſhall give from one of the moſt curious Anatomiſts of that Part *(e)*. "Seeing, ſaith he, the Trajection and Diſtribution of the Blood depends "wholly on the Syſtole of the Heart, and that its "Liquor is not driven of its own Nature ſo readily "into the upper Parts as into Veſſels even with it, "or downwards into thoſe under it: If the Situation of the Heart had been farther from the Head, "it muſt needs either have been made ſtronger to "caſt out its Liquor with greater Force; or elſe "the Head would want its due Proportion of "Blood. But in Animals that have a longer Neck, "and which is extended towards their Food as it "were, the Heart is ſeated as far from the other "Parts; and they find no Inconvenience from it, "becauſe they feed with their Head for the moſt "part hanging down; and ſo the Blood, as it hath "farther to go to their Head than in others, ſo it "goes a plainer and often a ſteep Way *(f)*."

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tricle of the Heart, there was another, which penetrated into the Arteria Venoſa, *and from thence into the left Ventricle, and afterwards into the* Aorta. *This Hole, called the* Foramen Ovale *in the* Fœtus, *makes the* Anaſtomoſis, *by the Means of which, the Blood goes from the* Cava *into the* Aorta, *without paſſing through the Lungs.* French Anatomiſts, *p.* 124.

(d) Τὴν τε Καρδίαν περὶ τὸ μέσον πλὴν ἐν Ανθρώπῳ, &c. *Ariſt. Hiſt. An.* lib. ii. cap. 17.

(e) Dr. *Lower de Corde*, cap. i.

(f) I might have mentioned another wiſe Proviſion from the ſame Author, which take in his own Words: *In Vitulis &*

The other peculiar Matter is, the faſtening (I formerly mentioned) which the Cone of the *Pericardium* hath in Man to the *Diaphragm (g)*, whereas in all *Quadrupeds* it is looſe. By which Means the Motion of the *Midriff*, in that neceſſary Act of Reſpiration, is aſſiſted both in the upright Poſture of Man, as alſo in the prone Poſture of *Quadrupeds (h)*, which would be hindered, or rendered more Difficult, if the Caſe was otherwiſe: "Which muſt "needs be the Effect of Wiſdom and Deſign, and "that Man was intended by Nature to walk erect, "and not upon all-four, as *Quadrupeds* do:" To expreſs it in the Words of a great Judge in ſuch Matters *(i)*.

Equis, imò plerique aliis animalibus majoribus, non ſolas propagines à Nervo ſexti paris ut in Homine, ſed etiam plurimas à Nervo intercoſtali, ubi rectà cor tranſit, cor accedere, imò in parenchyma ejus dimitti: & hoc ideo à Naturâ quaſi ſubſidium Brutis comparatum, ne capita quæ terram prona ſpectant, non ſatis facile aut copiosè Spiritus Animales impertirent. Blaſii Anat. Animal. Par. i. cap. 4. ex Lowero, de Corde.

(g) Diaphragmatis circulo nerveo firmiter adhæret [Pericardium] *quod Homini ſingulare; nam ab eo in Canibus & Simiis diſtat, item in aliis animalibus omnibus.* Bartholin. Anat. lib. ii. cap. 5.

(h) Finalem cauſam quod attinet,—cùm erectus ſit Hominis inceſſus atque figura, eoque faciliùs abdominis viſcera ſuo pondere deſcendant, minore Diaphragmatis nixu atque Syſtole ad Inſpirationem opus eſt: porrò, cùm in Exſpiratione pariter neceſſarium ſit Diaphragma relaxari,—cùm capſulæ cordis omnino connectendum fuit, in Homine, ne fortè, quandiu erectus incedit, ab Hepatis, aliorumque viſcerum appenſorum pondere deorſum adeò deprimeretur, ut neque Pulmo ſatis concidere, neque Exſpiratio debito modo peragi potuerit. Quacirca in Quadrupedibus, ubi abdominis viſcera in ipſum Diaphragma incumbunt, ipſumque in pectoris cavitatem ſuo pondere impellunt, iſta partium accretio Exſpirationi quidem inutilis, Inſpirationi autem debitam Diaphragmatis tenſionem impediendo, prorſus incommoda fuiſſet. Lower, ib. p. 8.

(i) Dr. Tyſon's *Anatomy of the Orang-Outang, in* Ray's *Wiſdom of God*, p. 262.

CHAP. VI.

Of the Difference between Man and Quadrupeds in the Nervous Kind.

THERE is only one Difference more between *Man* and *Quadrupeds* that I ſhall take Notice of, and that is the Nervous Kind: And becauſe it would be tedious to inſiſt upon many Particulars (*a*), I ſhall, for a Sample, inſiſt chiefly upon one; and that is, of Nature's prodigious Care for a due Communication and Correſpondence between the Head and Heart of Man, more than what is in the four-footed Tribe. For this Purpoſe, beſides the Correſpondence thoſe Parts have by Means of the Nerves of the *Par Vagum*, (common both to Man and Beaſt) there is a farther and more ſpecial Communication and Correſpondence occaſioned by the Branches (*b*) of the *Intercoſtal Pair*, ſent from the *Cervical Plexus* to the Heart, and *Præcordia*. By

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(*a*) Amongſt theſe, I might name the Site of the Nerves proceeding from the *Medulla Spinalis*, which Dr. *Lower* takes notice of. In Beaſts, whoſe Spine is above the reſt of the Body, the Nerves tend directly downwards; but in Man, it being erect, the Nerves ſpring out of the Spine, not at Right, but in Oblique Angles downwards, and paſs alſo in the Body the ſame Way. Ibid. p. 16.

(*b*) *In pleriſque Brutis tantùm hâc viâ* (i. e. by the *Par vagum*) *& vix omnino per ullos Paris Intercoſtalis Nervos, aditus ad cor aut Appetitum ejus pateſcit. Verùm in Homine, Nervus Intercoſtalis, præter Officia ejus in imo ventre huic cum cæteris animalibus communia, etiam ante pectoris clauſtra internuncii ſpecialis loco eſt, qui Cerebri & Cordis ſenſa mutua ultra citraque refert.* Willis Nervor. Deſcr. & Uſus, cap. 26.

which Means the Heart and Brain of Man have a mutual and very intimate Correſpondence and Concern with each other, more than is in other Creatures; or, as one of the moſt curious Anatomiſts and Obſervers of theſe Things ſaith (*c*): Brutes "are as it were Machines made with a ſimpler and leſs operoſe *Apparatus*, and endowed "therefore with only one and the ſame Kind of Motion, are determined to do the ſame Thing: "Whereas in Man, there is a great Variety of "Motions and Actions. For by the Commerce "of the aforeſaid *Cervical Plexus* (*d*) he ſaith, The "Conceptions of the Brain preſently affect the "Heart, and agitate its Veſſels and whole Appendage together with the *Diaphragm*. From whence "the Alteration in the Motion of the Blood, the "Pulſe, and Reſpiration. So alſo, on the contrary, when any Thing affects or alters the Heart, "thoſe Impreſſions are not only retorted to the "Brain by the ſame Duct of the Nerves, but alſo "the Blood itſelf (its Courſe being once changed) "flies to the Brain with a different and unuſual "Courſe, and there agitating the animal Spirits "with divers Impulſes, produceth various Conceptions and Thoughts in the Mind." And he tells us, "That hence it was that the ancient "Divines and Philoſophers too, made the Heart "the Seat of Wiſdom; and, certainly (ſays he)

(*c*) Id. Ib. *Dum hanc utriuſque ſpeciei differentiam perpendo ſuccurrit animo, Bruta eſſe velut machinas,* &c.

(*d*) That our great Man was not miſtaken, there is great Reaſon to imagine, from what he obſerved in diſſecting a *Fool*. Beſides the Brain being but ſmall, he ſaith, *Præcipua autem diſcriminis nota quam inter illius & viri cordati partes advertimus, hæcce erat; nempe quod prædictus Nervi Intercoſtalis Plexus, quem Cerebri & Cordis internunciam & Hominis proprium diximus, in Stulto hoc valde exilis, & minori nervorum ſatellitio ſtipatus fuerit.* Ibid.

“ the Works of Wiſdom and Virtue do very much “ depend upon this Commerce which is between “ the Heart and Brain:” And ſo he goeth on with more to the ſame Purpoſe. Upon the Account of this *Intercoſtal Commerce* with the Heart, being wanting in Brutes, there is another ſingularly careful and wiſe Proviſion the infinite Creator hath made in them, and that is, That by Reaſon both the *Par Vagum*, and the *Intercoſtal* too, do not ſend their Branches to the Heart, and its Appendage in Brutes; therefore, leſt their Heart ſhould want a due Proportion of Nervous Veſſels, the *Par Vagum* ſends more Branches to their Heart than to that of Man. This, as it is a remarkable Difference between rational and irrational Creatures; ſo it is as remarkable an Argument of the Creator's Art and Care; who, although he hath denied Brute-Animals Reaſon, and the Nerves miniſtring thereto, yet hath another Way ſupplied what is neceſſary to their Life and State. But let us hear the ſame great Author's Deſcant upon the Point *(e)*; “ Inaſmuch, ſaith he, as Beaſts are void of Diſ“ cretion, and but little ſubject to various and dif“ ferent Paſſions, therefore there was no Need that “ the Spirits, that were to be conveyed from the “ Brain to the *Præcordia*, ſhould paſs two different “ Ways, namely, one for the Service of the vital “ Functions, and another for the reciprocal Impreſ“ ſions of the Affections; but it was ſufficient that “ all their Spirits, whatever Uſe they were deſign“ ed for, ſhould be conveyed one and the ſame “ Way.”

Here now in the *Nervous Kind* we have manifeſt Acts of the Creator's Deſign and Wiſdom, in this ſo manifeſt and diſtinct a Proviſion for rational and

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(e) Id. ib. cap. 29. *In quantum Beſtiæ prudentiâ carent, & variis diverſiſque paſſionibus, &c.*

irrational Creatures; and that *Man* was evidently intended to be the one, as the *Genus* of *Quadrupeds* was the other.

CHAP. VII.

The Concluſion.

AND now it is time to pauſe a while, and reflect upon the whole. And as from the Conſiderations in the preceding BOOK, we have eſpecial Reaſon to be thankful to our infinitely merciful Maker, for his no leſs Kind than Wonderful Contrivances of our Body; ſo we have Reaſon, from this brief View I have taken of this laſt Tribe of the Creation, to acknowledge and admire the ſame Creator's Work and Contrivances in them. For we have here a large Family of Animals, in every particular Reſpect, curiouſly contrived and made, for that eſpecial Poſture, Place, Food, and Office or Buſineſs which they obtain in the World. So that if we conſider their own particular Happineſs and Good, or Man's Uſe and Service; or if we view them throughout, and conſider the Parts wherein they agree with Man, or thoſe eſpecially wherein they differ; we ſhall find all to be ſo far from being Things fortuitous, undeſigned, or any Way accidental, that every Thing is done for the beſt; all wiſely contrived, and incomparably fitted up, and every Way worthy of the great Creator. And he that will ſhut his Eyes, and not ſee GOD *(a)* in theſe his Works, even of the poor Beaſts of the Earth, that will not ſay (as *Elihu* hath it, *Job* xxxv. 10, 11.) *Where is God my Maker, who teacheth us more than the Beaſts of the Earth, and maketh us wiſer than the Fowls of the Heaven?* Of ſuch an one we may uſe the Pſalmiſt's Expreſſion, *Pſal.* xlix. 12. That *he is like the Beaſts* (b) *that periſh.*

(a) — *Deum namque ire per omnes*
Terraſque tractuſque Maris, Cœlumque profundum.
Hinc Pecudes, Armenta viros, genus omne Ferarum.
Virgil. Georg. lib. iv.

(b) *Illos qui nullum omnino Deum eſſe dixerunt, non modo non Philoſophos, ſed ne homines quidem fuiſſe dixerim; qui, mutis ſimillimi, ex ſolo corpore conſtiterunt, nihil videntes animo.* Lactant. lib. vii. cap. 9.

BOOK VII.

A SURVEY of BIRDS.

HAVING briefly, as well as I could, diſpatched the Tribe of *Quadrupeds*, I ſhall next take a brief and tranſient View of the *feathered Tribe*.

And here we have another large province to expatiate in, if we ſhould deſcend to every Thing wherein the Workmanſhip of the Almighty appears. But I muſt contract my *Survey* as much as may be; and ſhall therefore give only ſuch Hints and Touches upon this curious Family of Animals, as may ſerve for Samples of the reſt of what might be obſerved.

CHAP. I.

Of the Motion of Birds, and the Parts miniſtring thereto.

AS this Tribe hath a different Motion from that of other Animals, and an amphibious Way of Life; partly in the Air, and partly on the Land and Waters; ſo is their Body accordingly ſhaped, and all their Parts incomparably fitted for that Way of

Life and Motion; as will be found by a curſory View of ſome of the Particulars. And the

I. And moſt viſible Thing, is the Shape and Make of their Body, not thick and clumſy, but incomparably adapted to their Flight: Sharp before, to pierce and make Way through the Air, and then by gentle Degrees riſing to its full Bulk. To which we may add,

II. The neat Poſition of the *Feathers* throughout the Body; not ruffled, or diſcompoſed, or placed ſome this, ſome a contrary Way, according to the Method of Chance; but all artificially placed *(a)*, for facilitating the Motion of the Body, and its Security at the ſame Time, by way of Cloathing: And for that End, moſt of the Feathers tend backward, and are laid over one another in exact and regular Method, armed with warm and ſoft Down next the Body, and more ſtrongly made, and curiouſly cloſed next the Air and Weather, to fence off the Injuries thereof. To which Purpoſe, as alſo for the more eaſy and nimble gliding of the Body through the Air, the Proviſion Nature hath made, and the Inſtinct of theſe Animals to *preen* and *dreſs* their Feathers, is admirable; both in Reſpect of their Art and Curioſity in doing it, and the *Oil-bag (b)*, Glands, and whole Apparatus for that Service.

(a) See before *Book* IV. *Chap.* 12. *Note (l).*

(b) Mr. *Willughby* ſaith, there are two Glands for the Secretion of the unctuous Matter in the *Oil-bag*. And ſo they appear to be in Geeſe. But upon Examination, I find, that in moſt other Birds (ſuch at leaſt as I have enquired into,) there is only one Gland; in which are divers little Cells, ending in two or three larger Cells, lying under the Nipple of the *Oil-bag*. This *Nipple* is perforated, and being preſſed, or drawn by the Bird's Bill, or Head, emits the liquid Oil, as it is in ſome Birds, or thicker unctuous Greaſe, as it is in others. The whole *Oil-bag* is in its Structure ſomewhat conformable to the Breaſts of ſuch Animals as afford Milk.

III. And now having ſaid thus much relating to the Body's Motion, let us ſurvey the Grand Inſtrument thereof, the *Wings.* Which as they are principal Parts, ſo are made with great Skill, and placed in the moſt commodious Point of the Body *(c)*, to give it an exact Equipoiſe in that ſubtile Medium, the Air.

And here it is obſervable, with what incomparable Curioſity every Feather is made; the *Shaft* exceeding ſtrong, but hollow below, for Strength and Lightneſs Sake; and above, not much leſs ſtrong, and filled with a *Parenchyma* or *Pith*, both ſtrong and light too. The *Vanes* as nicely gauged on each Side as made; broad on one Side, and narrower on the other; both which incomparably miniſter to the progreſſive Motion of the Bird, as alſo to the Union and Cloſeneſs of the Wing *(d)*.

And

(c) In all Birds that fly much, or that have the moſt Occaſion for their Wings, it is manifeſt that their Wings are placed in the very beſt Part, to balance their Body in the Air, and to give as ſwift a Progreſſion as their Wings and Body are capable of: For otherwiſe we ſhould perceive them to reel, and fly unſteadily; as we ſee them to do, if we alter their Æquipoiſe, by cutting the End of one of the Wings, or hanging a Weight at any of the extreme Parts of the Body. But as for ſuch Birds as have as much Occaſion for Swimming as Flying, and whoſe Wings are therefore ſet a little out of the Center of the Body's Gravity, ſee *Book* IV. *Chap.* 8. *Note (q)*, and for ſuch as have more Occaſion for Diving than Flying, and whoſe Legs are, for that Reaſon, ſet more backward, and their Wings more forward, *Chap.* iv. *Note (k)* of this *Book.*

(d) The wiſe Author of Nature hath afforded an Example of the great Nicety in the Formation of Birds, by the Nicety obſerved in a Part no more conſiderable than the Vanes of the Flag-feathers of the Wing. Among others, theſe two Things are obſervable: 1. The Edges of the Exterior or narrow Vanes bend downwards, but of the interior wider Vanes upwards; by which Means they catch, hold, and lie cloſe to one another, when the Wing is ſpread; ſo that not one Feather may miſs

And no leſs inquiſitive is the textrine Art of the *Plumage (e)* alſo; which is ſo curiouſly wrought;

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miſs its full Force and Impulſe upon the Air. 2. A yet leſſer Nicety is obſerved, and that is, in the very ſloping the Tips of the Flag-Feathers: The interior Vanes being neatly ſloped away to a Point, towards the outward Part of the Wing; and the exterior Vanes ſloped towards the Body, at leaſt in many Birds; and in the Middle of the Wing, the Vanes being equal, are but little ſloped. So that the Wing, whether extended or ſhut, is as neatly ſloped and formed, as if conſtantly trimmed with a Pair of Sciſſors.

(e) Since no exact Account, that I know of, hath been given of the Mechaniſm of the *Vanes*, or *Webs* of the Feathers, my Obſervation may not be unacceptable. The *Vane* conſiſts not of one continued Membrane, becauſe if one be broken, it would hardly be reparable; but of many *Laminæ*, which are thin, ſtiff, and ſomewhat of the Nature of a thin Quill. Towards the Shaft of the Feather, (eſpecially in the Flagfeathers of the Wing,) thoſe *Laminæ* are broad, *&c.* of a ſemicircular Form; which ſerve for Strength, and for the cloſer ſhutting of the *Laminæ* to one another, when Impulſes are made upon the Air. Towards the outward Part of the Vane, theſe *Laminæ* grow ſlender and taper: On their under Side they are thin and ſmooth, but their upper-outer Edge is parted into two hairy Edges, each Side having a different Sort of Hairs, laminated or broad at Bottom, and ſlender and bearded above the other half. I have, as well as I could, repreſented the uppermoſt Edge of one of theſe *Laminæ* in *Fig.* 18. with ſome of the Hairs on each Side, magnified with a Microſcope. Theſe bearded briſtles, or Hairs, on one Side the *Laminæ*, have ſtrait Beards, as in *Fig.* 19. thoſe on the other Side, have hooked Beards on one Side the ſlender Part of the Briſtle, and ſtrait ones on the other, as in *Fig.* 20. Both theſe Sorts of Briſtles magnified, (only ſcattering, and not cloſe,) are repreſented as they grow upon the upper Edge of the *Lamina ſ. t.* in *Fig.* 18. And in the Vane, the hooked Beards of one *Lamina*, always lie next the ſtrait Beards of the next *Lamina*; and by that Means lock and hold each other; and by a pretty Mechaniſm, brace the *Laminæ* cloſe to one another. And if at any Time the Vane happens to be ruffled and diſcompoſed, it can by this pretty eaſy Mechaniſm, be reduced and repaired. *Vide Book* IV. *Chap.* 12. *Note (m).*

and ſo artificially interwoven, that it cannot be viewed without Admiration, eſpecially when the Eye is aſſiſted with Glaſſes.

And as curiouſly made, ſo no leſs curiouſly are the Feathers placed in the Wing, exactly according to their ſeveral Lengths and Strength: The *Principals* ſet for Stay and Strength, and theſe again well lined, faced, and guarded with the *Covers* and *Secondary Feathers*, to keep the Air from paſſing through, whereby the ſtronger Impulſes are made thereupon.

And laſtly, to ſay no more of this Part, that deſerves more to be ſaid of it, what an admirable *Apparatus* is there of *Bones*, very ſtrong, but withal light and incomparably wrought? of *Joints*, which open, ſhut, and every way move, according to the Occaſions either of extending it in Flight, or withdrawing the Wing again to the Body? and of various *Muſcles*; among which the peculiar Strength of the *Pectoral Muſcles* deſerves eſpecial Remark, by Reaſon they are much ſtronger (*f*) in Birds than in Man, or any other Animal, not made for Flying.

IV. Next the Wings, the Tail is in Flight conſiderable; greatly aſſiſting in all Aſcents and De-

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(*f*) *Pectorales Muſculi Hominis flectentes humeros, parvi & parum carnoſi ſunt; non æquant 50am aut 70am partem omnium Muſculorum Hominis. E contra in Avibus, Pectorales Muſculi vaſtiſſimi ſunt, & æquant, imò excedunt, & magis pendent, quàm reliqui omnes Muſculi ejuſdem Avis ſimul ſumpti.* Borell. de Mot. Animal. vol. i. Prop. 184.

Mr. *Willughby* having made the like Obſervation, hath this Reflection on it: *Whence, if it be poſſible for Man to fly, it is thought by them who have curiouſly weighed and conſidered the Matter, that he that would attempt ſuch a thing with Hopes of Succeſs, muſt ſo contrive and adapt his Wings, that he may make Uſe of his Legs, and not his Arms, in managing them:* (becauſe the Muſcles of the Legs are ſtronger, as he obſerves.) Willugh. Ornith. lib. i. cap. 1. ſect. 19.

ſcents in the Air, as alſo ſerving to ſteady (g) Flight, by keeping the Body upright in that ſubtile and yielding *Medium*, by its readily turning and anſwering every Vacillation of the Body.

And now to the Parts ſerving to Flight, let us add the nice and complete Manner of its Performance; all done according to the ſtricteſt rules of Mechaniſm (h). What Rower on the Waters, what Artiſt on the Land, what acuteſt Mathematician could give a more agreeable and exact Motion to the Wings, than theſe untaught flying Artiſts do theirs! Serving not only to bear their Bodies up in the Air, but alſo to waft them along therein, with a ſpeedy progreſſive Motion, as alſo to ſteer and turn them this Way and that Way, up and down, faſter or ſlower, as their Occaſions require, or their Pleaſure leads them.

V. Next to the Parts for Flight, let us view the *Feet* and *Legs* miniſtring to their other Motion: Both made light, for eaſier Tranſportation through the Air; and the former ſpread, ſome with Membranes for Swimming (i), ſome without, for ſteady

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(g) Mr. *Willughby*, *Ray*, and many others, imagine the principal Uſe of the Tail to be to ſteer and turn the Body in the Air, as a Rudder. But *Borelli* hath put it beyond all Doubt, that this is the leaſt Uſe of it, and that it is chiefly to aſſiſt the Bird in its Aſcents and Deſcents in the Air, and to obviate the Vacillations of the Body and Wings. For as for turning to this or that Side, it is performed by the Wings and Inclination of the Body, and but very little by the help of the Tail.

(h) See *Borelli ubi ſupra*, Prop. 182, &c.

(i) It is conſiderable in all Water-Fowl, how exactly their Legs and Feet correſpond to that Way of Life. For either their Legs are long, to enable them to wade in the Waters: In which caſe, their Legs are bare of Feathers a good way above the Knees, the more conveniently for this Purpoſe. Their Toes alſo are all abroad; and in ſuch as bear the Name of *Mudſuckers*, two of the Toes are ſomewhat joined, that

Going, for Perching, for Catching and Holding of Prey *(k)*, or for Hanging by the Heels to gather their Food *(l)*, or to fix themſelves in their Places of Retreat and Safety. And the latter, namely, the *Legs*, all curved for their eaſy Perching, Rooſting, and Reſt, as alſo to help them upon their Wings in taking their Flight, and to be therein commodiouſly tucked up to the Body, ſo as not to obſtruct their Flight. In ſome long, for Wading and Searching the Waters; in ſome of a moderate Length, anſwerable to their vulgar Occaſions; and in others as remarkably ſhort, to anſwer their eſpecial Occaſions and Manner of Life *(m)*. To all theſe let us add the placing theſe laſt men-

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that they may not eaſily ſink in walking upon boggy Places. And as for ſuch as are whole-footed, or whoſe Toes are webbed together, (excepting ſome few) their Legs are generally ſhort, which is the moſt convenient Size for Swimming. And it is pretty enough to ſee how artificially they gather up their Toes and Feet when they withdraw their Legs, or go to take their Stroke; and as artificially again extend or open their whole Foot, when they preſs upon, or drive themſelves forward in the Waters.

(k) Some of the Characteriſticks of Rapacious Birds, are, *to have hooked, ſtrong, and ſharp-pointed Beaks and Talons, fitted for Rapine, and tearing of Fleſh; and ſtrong and brawny Thighs, for ſtriking down their Prey.* Willughby Ornith. lib. ii. cap. 1. Raii Synopſ. Av. Method. p. 1.

(l) Such Birds as climb, particularly thoſe of the *Wood-pecker* Kind, have for this Purpoſe, (as Mr. *Willughby* obſerves, lib. ii. cap. 4.) 1. Strong and muſculous Thighs. 2. Short Legs and very ſtrong. 3. Toes ſtanding two forwards and two back-wards. Their Toes alſo are cloſe joined together, that they may more ſtrongly and firmly lay hold on the Tree they climb upon. 4. All of them — have a hard ſtiff Tail, bending alſo downwards, on which they lean, and ſo bear up themſelves in climbing.

(m) *Swifts* and *Swallows* have remarkably ſhort Legs, eſpecially the former, and their Toes graſp any thing very ſtrongly. All which is uſeful to them in building their Neſts, and other ſuch Occaſions as neceſſitate them to hang frequently

by

mentioned Parts in the Body. In all ſomewhat out of the Center of the Body's Gravity *(n)*, but in ſuch as ſwim more than in others, for the better rowing their Bodies through the Waters, or to help them in that Diving *(o)* too.

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by their Heels. But there is far greater Uſe of this Structure of their Legs and Feet, if the Reports be true of their hanging by the Heels in great Cluſters (after the manner of Bees) in Mines and Grottos, and on the Rocks by the Sea, all the Winter. Of which latter, I remember the late learned Dr. *Fry* told this Story at the Univerſity, and confirmed it to me ſince, *viz.* That an antient Fiſherman, accounted an honeſt Man, being near ſome Rocks on the Coaſt of *Cornwall*, ſaw at a very low Ebb, a black liſt of ſomething adhering to the Rock, which when he came to examine, he found it was a great number of *Swallows*, and, if I miſremember not, of *Swifts* alſo, hanging by the Feet to one another, as Bees do; which were covered commonly by the Sea-Waters, but revived in his warm Hand, and by the Fire. All this the Fiſherman himſelf aſſured the Doctor. Of this, ſee more *Chap.* iii. *Note (d)* of this Book.

(n) In the Birds that frequent not the Waters, the Wings are in the Center of Gravity, when the Bird lies along, as in Flying; but when it ſtands or walks, the Erection of the Body throws the Center of Gravity upon the Thighs and Feet.

(o) See *Chap.* iv. *Note (k).*

CHAP. II.

Of the Head, Stomach, and other Parts of Birds.

THUS having diſpatched the Parts principally concerned in the Motion of the *Feathered Tribe*, let us proceed to ſome other Parts not yet animadverted upon. And we will begin with the *Head*,

Head, concerning which I have already taken notice of its Shape for making way through the Air; of the Make of the *Bill*, for gathering Food, and other Uſes; the commodious Situation of the *Eye*; and I might add that of the *Ear* too, which would be in the Way, and obſtruct Flight, if it was like that of moſt other Animals: Alſo I might ſay a great deal of the Conformation of the *Brain*, and of the Parts therein wanting, and of others added, like to what is obſervable in Fiſhes; whoſe Poſture in the Waters reſembles that of Birds in the Air (*a*), and both very different from Man and Beaſts: and laſtly, to hint at no more, I might ſurvey the peculiar Structure of the *Larynx* (*b*), the

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(*a*) *Cerebra Hominum & Quadrupedum in pleriſque ſimilia exiſtunt. — Capitibus Volucrum & Piſcium contenta ab utriſque prioribus longè diverſa, tamen inter ſe, quoad præcipuas ἐγκεφάλου partes Symbola reperiuntur.* The particulars wherein the Brains of Birds and Fiſhes agree with one another, and wherein they differ from the Brain of Man and Beaſts, ſee in the ſame juſtly famous Author, *Willis Cereb. Anat.* cap. 5.

(*b*) *Circa bifurcationem Aſperæ Arteriæ, elegans Artificis liberè agentis indicium detegitur ex Avium comparatione cum Quadrupedibus: cùm Vocis gratia in diverſis Avibus diverſam muſculorum fabricam bifurcationi Aſperæ Arteriæ dederit, quorum nullum veſtigium extat in Homine & Quadrupedibus mihi viſis; ubi omnes vocis muſculos capiti Arteriæ junxit. In Aquilâ, &c. ſupra bifurcationem, &c.* Steno in Blaſ. Anat. Animal. p. ii. cap. 4.

The *Aſpera Arteria* is very remarkable in the *Swan*, which is thus deſcribed by *T. Bartholin*, viz. *Aſpera Arteria admirandæ ſatis ſtructuræ. Nam pro Colli longitudine deorſum Oeſophagi, comes protenditur donec ad ſternum perveniat, in cujus capſulam ſe incurvo flexu inſinuat & recondit, velut in tuto loco & thecâ, moxque ad fundum ejuſdem cavitatis delata ſurſum reflectitur, egrediturque anguſtias Sterni, & Claviculis mediis concenſis, quibus ut fulcro nititur, ad Thoracem ſe flectit — Miranda hercle modis omnibus conſtitutio & Reſpirationi inſervit & Voci. Nam cùm in ſtagnorum fundo edulia pro victu quærat, longiſſimo indiguit collo ne longa mora ſuffocationis incur-*

re

the *Tongue*, *(c)*, the inner Ear *(d)*, and many matters beſides;

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re et periculum. Et certè dum dimidiam fere horam toto Capite & Collo pronis vado immergitur, pedibus in altum elatis cœloque obverſis, ex eâ Arteriæ quæ pectoris dictæ vaginæ recluſa eſt portione, tanquam ex condo promo ſpiritum haurit. Blaſ. ib. cap. 10.

(c) The Structure of the *Tongue* of the *Wood Pecker* is very ſingular and remarkable, whether we look at its great Length, its Bones and Muſcles, its encompaſſing Part of the Neck and Head, the better to exert itſelf in Length; and again, to retract it into its Cell; and laſtly, whether we look at its ſharp, horny, bearded Point, and the gluey Matter at the End of it, the better to ſtab, to ſtick unto, and draw out little Maggots out of Wood. *Utilis enim Picis* (ſaith *Coiter) ad Vermiculos, Formicas, aliaque Inſecta venanda talis Lingua foret. Siquidem Picus, innata ſuâ ſagacitate cùm deprehendit alibi in arboribus, vel carie, vel aliâ de cauſâ cavatis, Vermes inſectaque deliteſcere, ad illos volitat, ſeſeque digitis unguliſque poſterioribus robuſtiſſimis, & Caudæ pennis rigidiſſimis ſuſtentat, donec valido ac peracuto Roſtro arborem pertundat: arbore pertuſâ, foramini roſtrum immittit, ac quo animalcula ſtridore excitet percellatque, magnum in arboris cavo emittit vocem, inſecta vociferatione hâc concitata huc illucque repunt; Picus v linguam ſuam exerit, atque aculeis, hamiſque animalia infigit, infixa attrahit & devorat.* Vide Blaſii ubi ſupra, p. ii. cap. 24.

(d) I have before, in *Book* IV. *Chap.* 3. *Note (u)*, taken notice of what others have obſerved concerning the *inner Ear* of *Birds*, reſerving my own Obſervations for this Place: Which I hope may be acceptable, not only for being ſome of them new, but alſo ſhewing the Mechaniſm of Hearing, in General.

In this Organ of Birds, I ſhall take notice only of three Parts, the *Membranes* and *Cartilages*; the *Columella*; and the *Conclave:* The *Drum*, as ſome call it, or *Membrana Tympani*, as others, conſiſts of two Membranes; the Outer, which covers the whole *Meatus*, Baſon, or *Drum*, (as ſome call it) and the inner Membrane. To ſupport, diſtend, and relax the outermoſt, there is one ſingle Cartilage, reaching from the Side of the *Meatus*, to near the Middle of the Membrane. On the Top of the *Columella* is another Cartilage, conſiſting of three Branches, *a. b. c.* in *Fig.* 23. The longeſt middle Branch *a.* is joined to the Top of the ſingle upper Cartilage before ſpoken of, and aſſiſts it to bear up the upper outer Membrane; The two Branches, *b, c.* are joined to the

Os Petroſum, at ſome Diſtance from the outer Membrane: Upon this inner Cartilage, is the inner Membrane fixed, the two outer Sides of which, *a. b.* and *a. c.* are joined to the outer Membrane, and make a kind of three-ſquare Bag. The Deſign of the two Branches or Legs of the Cartilage, *b. c.* are, I conceive, to keep the *Cartilage* and *Columella* from wavering Side-ways, and to hinder them from flying too much back: There is a very fine ſlender Ligament extended from the oppoſite Side, quite croſs the *Meatus* or Baſon, to the Bottom of the *Cartilage*, near its joining to the *Columella*. Thus much for the *Membranæ Tympani*, and their *Cartilages*.

The next Part is the *Columella* (as *Schelhammer* calls it.) This is a very fine, thin, light, bony Tube; the Bottom of which ſpreads about, and gives it the Reſemblance of a wooden Pot-lid, ſuch as I have ſeen in Country Houſes. It exactly ſhuts into, and covers a *Foramen* of the *Conclave*, to which it is braced all round, with a fine ſubtile Membrane, compoſed of the tender Auditory Nerve. This Bottom or Baſe of the *Columella*, I call the *Operculum*.

The laſt Part, which ſome call the *Labyrinth* and *Cochlea*, conſiſting of Branches more like the *Canales Semicirculares* in Man, than the *Cochlea*, I call the *Conclave Auditûs*. It is (as in moſt other Animals) made of hard context Bone. In moſt of the Birds I have opened, there are *circular Canals*, ſome larger, ſome leſſer, croſſing one another at right Angles, which open into the *Conclave*. But in the *Gooſe* it is otherwiſe, there being cochleous Canals, but not like thoſe of other Birds. In the *Conclave*, at the Side oppoſite to the *Operculum*, the tender Part of the *Auditory Nerve* enters and lineth all thoſe inner retired Parts, *viz.* the *Conclave* and *Canals*.

As to the *Paſſages*, *Columnæ*, and other Parts obſervable in the Ear of Birds, I ſhall paſs them by, it being ſufficient to my Purpoſe, to have deſcribed the Parts principally concerned in the Act of Hearing. And as the Ear is in Birds the moſt ſimple and incomplex of any Animal's Ear; ſo we may from it make an eaſy and rational Judgment, how *Hearing* is performed, *viz.* *Sound* being a *Tremor* or *Undulation* in the Air, cauſed by the Colliſion of Bodies, doth, as it moves along, ſtrike upon the *Drum*, or *Membrana Tympani*, of the Ear: Which Motion, whether ſtrong or languid, ſhrill or ſoft, tuneful or not, is at the ſame Inſtant impreſſed upon the *Cartilages*, *Columella*, and *Operculum*, and ſo communicated to the *Auditory Nerve* in the *Conclave*.

And now if we compare the Organ and Act of Hearing with thoſe of Sight, we ſhall find that the *Conclave* is to Hearing, as the *Retina* is to Sight; that ſonorous Bodies make their beſides; but for a Sample, I ſhall only inſiſt upon the wonderful Proviſion in the Bill for the judging of the Food, and that is by peculiar Nerves lodged therein for that Purpoſe; ſmall and leſs numerous in ſuch as have the Aſſiſtance of another Senſe, the Eye; but large, more numerous, and thickly branched about, to the very End of the Beak, in ſuch as hunt for their Food out of Sight in the Waters, in Mud, or under Ground *(e)*.

And

Impreſſions thereby on the Brain, as viſible Objects do by the *Retina*. Alſo, that as there is an *Apparatus* in the Eye, by the opening and ſhutting of the Pupil, to make it correſpond to all the Degrees of Light, ſo there is in the Ear, to make it conformable to all the Degrees of Sound, a noble Train of little Bones and Muſcles in Man, &c. to ſtrain and relax the Membrane, and at the ſame Time to open and ſhut the *Baſis* of the *Stapes* (the ſame as what I call the *Operculum* in Birds:) But in Birds there is a more ſimple, but ſufficient *Apparatus* for this Purpoſe, tender Cartilages, inſtead of Bones and Joints, to correſpond to the various Impreſſions of Sounds, and to open and ſhut the *Operculum*. Beſides which, I ſuſpect the Ligament I mentioned, is only the Tendon of a Muſcle, reaching to the inner *Membrana Tympani*, and joined thereto, (as I find by a ſtricter Scrutiny) and not to the Cartilage, as I imagined. By this Muſcle, the inner Membrane, and by Means of that the Outer alſo, can be diſtended or relaxed, as it is in Man, by the *Malleus* and its Muſcle, &c.

(e) *Flat billed Birds, that grope for their Meat, have three Pair of Nerves, that come into their Bills, whereby they have that Accuracy to diſtinguiſh what is proper for Food, and what to be rejected by their Taſte, when they do not ſee it. This was moſt evident in a Duck's Bill and Head; Ducks having larger Nerves that come into their Bills than Geeſe, or any other Bird that I have ſeen; and therefore quaffer and grope out their Meat the moſt. But then I diſcovered none of theſe Nerves in round-billed Birds. But ſince, in my Anatomies in the Country in a Rook, I firſt obſerved two Nerves that came down betwixt the Eyes into the upper Bill, but conſiderably ſmaller than any of the three Pair of Nerves in the Bills of Ducks, but larger than the Nerves in any other round-billed Birds. And it is remarkable that theſe Birds, more than any other round-billed Birds, ſeem to grope*

for

And now from the Head and Mouth paſs we to its near Ally, the Stomach, another no leſs notable than uſeful Part; whether we conſider the Elegancy of its Fibres and Muſcles, or its Multiplicity; one to ſoften and macerate, another to digeſt; or its Variety, ſuited to various Foods, ſome membranous, agreeable to the frugivorous, or carnivorous Kind; ſome muſculous and ſtrong (f), ſuited to the Comminution, and grinding of Corn and Grain, and ſo to ſupply the Defect of Teeth.

And now to this Specimen of the Parts, I might add many other Things, no leſs curiouſly contrived, made, and ſuited to the Occaſions of theſe Volatiles; as particularly the Structure and Lodgment of the *Lungs (g):* the Configuration of the *Breaſt*, and

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for their Meat in Cow-dung, &c. *Mr.* J. Clayton, *in* Philoſ. Tranſ. N° 206.

I obſerved three Pair of Nerves in all the broad-billed Birds that I could meet with, and in all ſuch as feel for their Food out of Sight, as Snipes, Woodcocks, Curlews, Geeſe, Ducks, Teals, Widgeons, &c. *Theſe Nerves are very large, equalling almoſt the Optic Nerve in Thickneſs. — Two are diſtributed nigh the End of the upper Bill, and are there very much expanded, paſſing through the Bone into the Membrane, lining the Roof of the Mouth.* Dr. *A. Moulen*, ibid. N° 199. Or both in Mr. *Lowthorp*'s Abridg. vol. ii. p. 861, 862.

(f) The *Gizzard* is not only made very ſtrong, eſpecially in the Granivorous; but hath alſo a Faculty of Grinding what is therein: For which Purpoſe, the Bird ſwalloweth rough Stones down, which when grown ſmooth, are rejected and caſt out of the Stomach, as uſeleſs. This Grinding may be heard in Falcons, Eagles, *&c.* by laying the Ear cloſe to them, when their Stomachs are empty, as the famous Dr. *Harvey* ſaith, *De Generat. Exer. 7.*

As to the Strength of the *Gizzard*, and Uſe of Stones to the Digeſtion of Fowls, divers curious Experiments may be met with, tried by Signeur *Redi*, with Glaſs Bubbles, ſolid Glaſs, Diamonds, and other hard Bodies. See his *Exp. Nat.*

(g) It is no leſs remarkable in Birds, that their *Lungs* adhere to the *Thorax*, and have but little Play, than that in other and its Bone, made like a Keel, for commodious Paſſage through the Air, to bear the large and ſtrong Muſcles, which move the Wings, and to counterpoiſe the Body, and ſupport and reſt it upon at Rooſt. The *Neck* alſo might deſerve our Notice, always either exactly proportioned to the Length of the Legs, or elſe longer, to hunt out Food, to ſearch in the Waters *(h)*; as alſo to counterpoiſe the Body in Flight *(i)*. And laſtly, I might here take

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other Animals they are looſe, and play much, which is a good Proviſion for their ſteady Flight. Alſo they want the *Diaphragm*, and inſtead thereof, have divers large Bladders made of thin tranſparent Membranes, with pretty large Holes out of one into the other. Theſe Membranes ſeem to me to ſerve for *Ligaments*, or *Braces* to the *Viſcera*, as well as to contain Air. Towards the upper Part, each Lobe of the Lungs is perforated in two Places, with large Perforations; whereof one is towards the outer, the other towards the inner Part of the Lobe. Through theſe Perforations, the Air hath a Paſſage into the Belly, (as in *Book* I. *Chap.* 1. *Note (b)*;) that is, into the forementioned Bladders; ſo that by blowing into the *Aſpera Arteria*, the Lungs will be a little raiſed, and the whole Belly blown up, ſo as to be very turgid. Which doubtleſs is a Means to make their Bodies more or leſs buoyant, according as they take in more or leſs Air, to facilitate thereby their Aſcents, and Deſcents; like as it is in the *Air-Bladders* of Fiſhes, in the laſt cited Place, *Note (i)*.

(h) Such Birds as have long Legs, have alſo a long Neck; for that otherwiſe they could not commodiouſly gather up their Food, either on Land, or in the Water. But on the other Side, thoſe which have long Necks, have not always long Legs, as in Swans—whoſe Necks ſerve them to reach to the Bottom of Rivers, &c. Willughby's Ornithol. lib. i. cap. 1. ſect. 7.

(i) We have ſufficient Inſtances of this in *Geeſe*, *Ducks*, &c. whoſe Wings (their Bodies being made for the Convenience of Swimming) are placed out of the Center of Gravity, nearer the Head. But the extending the Neck and Head in Flight, cauſeth a due Æquipoiſe and Libration of the Body upon the Wings; which is another excellent Uſe of the long Necks of theſe Birds, beſides that of reaching and ſearching in the Waters for their Food.

But in the *Heron*, whoſe Head and long Neck (although tucked up in Flight,) over-balance the hinder Part of the Body;

take Notice of the Defect of the Diaphragm, ſo neceſſary in other Animals to Reſpiration; and alſo of divers other Parts redundant, defective, or varying from other Animals. But it would be tedious to inſiſt upon all; and therefore to the Examples already given, I would rather recommend a nice Inſpection (*k*) of thoſe curious Works of God, which would be manifeſt Demonſtrations of the admirable Contrivance and Oeconomy of the Bodies of thoſe Creatures.

From the Fabrick therefore of their Bodies, I ſhall paſs to a Glance of one or two Things, relating to their *State*; and ſo conclude this Genus of the Animal World.

CHAP. III.

Of the Migration of Birds.

Concerning the *State* of this Tribe of *Animals*, the firſt Thing I ſhall ſpeak of, (by Reaſon God himſelf inſtanceth in it,) ſhall be their Migration, mentioned *Jer.* viii. 7. *Yea, the Stork in the Heaven knoweth her appointed Times, and the Turtle,*

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dy; the long Legs are extended in Flight, to counterpoiſe the Body, as well as to ſupply what is wanting in the Tail, from the Shortneſs of it.

(*k*) *Steno* thus concludes his Myology of the Eagle, *Imperfecta hæc Muſculorum deſcriptio, non minùs arida eſt Legentibus, quàm Inſpectantibus fuerit jucunda eorundem præparatio. Elegantiſſima enim Mechanices artificia, creberrimè in illis obvia, verbis non niſi obſcurè exprimuntur, carnium autem ductu, tendinum colore, inſertionum proportione, & trochlearum diſtributione oculis expoſita omnem ſuperant admirationem.* Steno in Blaſ. Anat. Animal. p. ii. cap. 4.

tle, and the Crane, and the Swallow, obſerve the Time of their Coming; but my People, &c.

In which Act of Migration, there are two Things to me exceedingly notable. One is what the Text ſpeaks of, their knowing their proper Times for their *Paſſage*, when to come *(a)*, when to go; as alſo that ſome ſhould come, when others go; and ſome others go, when theſe come. There is no doubt but the Temperature of the Air, as to Heat and Cold, and their natural Propenſity to breed their Young, may be great Incentives to thoſe Creatures to change their Habitation: But yet it is a very odd Inſtinct, that they ſhould at all ſhift their Habitation; that ſome certain Place is not to be found in all the Terraqueous Globe, affording them convenient Food and Habitation all the Year, either in the colder Climes, for ſuch as delight in the colder Regions; or the hotter, for ſuch *Birds of Paſſage* as fly to us in Summer.

Alſo it is ſomewhat ſtrange, that thoſe untaught unthinking Creatures ſhould ſo exactly know the beſt and only proper Seaſons to go and come. This gives us good Reaſon to interpret the מועדיה *appointed Times (b)* in the Text, to be ſuch Times as the Creator hath appointed thoſe Animals, and hath accordingly, for this End, imprinted upon their Natures ſuch an Inſtinct, as exciteth and moveth them thus, at proper Times, to fly from a Place that would obſtruct their Generation, or not afford convenient Food for them, and their Young, and betake themſelves to another Place, affording all that is wanting for Food or Incubation.

(a) *Curioſa res eſt, ſcire quàm exactè hoc genus avium* [Gruum] *quotannis obſervet tempora ſui reditûs ad nos. Anno* 1667, *primæ Grues comparuerunt in campeſtribus Piſæ* 20 *Feb. &c.* F. Redi Exp. Nat. p. 100. ubi plura.

(b) From יעד *indixit, conſtituit, ſcil. locum, vel tempus, ubi vel quando aliquid fieri debet.* Buxt. in verb. *De voluntate ſuâ certiorem reddidit.* Con. Kircher Concordant. Pars 1. Col. 1846. מועד *Generaliter pro re aliquâ certâ, atteſtatâ, & definitâ accipitur.* 1. *Pro tempore certo & conſtituto.* 2. *Deinde pro feſto ſeu Solennitate, quæ certo & ſtato tempore celebratur.* 3. *Pro loco certo conſtituto.* Id. ibid. Col. 1847.

And this leads me to another Thing remarkable in this Act of Migration; and that is, That thoſe unthinking Creatures ſhould know what Way to ſteer their Courſe (*c*), and whither to go. What, but the Great Creator's Inſtinct, ſhould ever move a poor fooliſh Bird to venture over vaſt Tracts of Land, but eſpecially over large Seas? If it ſhould be ſaid, That by their high Aſcents up into the Air, they can ſee croſs the Seas; yet what ſhould teach or perſuade them, that that Land is more proper for their Purpoſe, than this? That *Britain* (for Inſtance,) ſhould afford them better Accommodations than *Egypt* (*d*), than the *Canaries*, than *Spain*, or

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(*c*) *Quis non cum admiratione videat ordinem & politiam peregrinantium Avium, in itinere, turmatim volantium, per longos terrarum & maris tractus abſque Acu marinâ?* — *Quis eas certum iter in aëris mutabili regione docuit? Quis præteritæ ſigna, & futuræ viæ indicia? Quis eas ducit, nutrit, & vitæ neceſſaria miniſtrat? Quis inſulas & hoſpitia illa, in quibus victum reperiant, indicavit; modumque ejuſmodi loca in peregrinationibus ſuis inveniendi? Hæc ſanè ſuperant hominum captum & induſtriam, qui non niſi longis experientiis, multis itinerariis, chartis geographicis,* — *& acûs magneticæ beneficio,* — *ejuſmodi marium & terrarum tractus conficere tentant & audent.* Lud. de Beaufort. Coſmop. Divina, ſect. v. cap. 1.

(*d*) I inſtance particularly in *Egypt*, becauſe Mr. *Willughby* thinks *Swallows* fly thither, and into *Ethiopia*, &c. and that they do not lurk in Holes, or under Water, as *Olaus Magnus* reports. *Vide Ornith.* lib. ii. cap. 3. But *Etmuller* puts the Matter out of Doubt, who ſaith, *Memini ne plures, quàm quas Medimnus caperit, Hirundines arctè coacervatas intra Piſcinæ cannas, ſub glacie prorſus ad ſenſum exanimes pulſantes tamen, reperiiſſe.* Etmuller Diſſert. ii. cap. 10. ſect. 5. This, as it is like what *Ol. Magnus* ſaith, ſo is a confirmation of it. The Archbiſhop's Account is, *In Septentrionalibus aquis ſæpius caſu Piſcatoris extrahuntur Hirundines, in modum conglo-*

or any of thoſe many intermediate Places over which ſome of them probably fly.

And laſtly, to all this, let us briefly add the Accommodations theſe *Birds of Paſſage have*, to enable them to take ſuch long Flights, *viz.* the Length of their Wings, or their more than ordinary Strength (*e*) for Flight.

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merata maſſæ, quæ ore ad os, & ala ad alam, & pede ad pedem poſt principium autumni ſeſe inter cannas deſcenſuræ colligârunt. —Maſſa autem illa per imperitos adoleſcentes — extracta, atque in æſtuaria portata, caloris acceſſu Hirundines reſolutæ, volare quidem incipiunt, ſed exiguo tempore durant. Ol. Mag. Hiſt. lib. xix. cap. 20.

Since my penning this Note, we had, at a Meeting of the Royal Society, *Feb.* 12. $171\frac{2}{3}$, a farther Confirmation of *Swallows* retiring under Water in Winter, from Dr. *Colas*, a Perſon very curious in theſe Matters; who ſpeaking of their Way of Fiſhing in the Northern Parts, by breaking Holes, and drawing their Nets under the Ice, ſaith, That he ſaw ſixteen Swallows ſo drawn out of the Lake of *Samrodt*, and about thirty out of the King's great Pond in *Roſineilen*; and that at *Schlebitten*, near an Houſe of the Earl of *Dohna*, he ſaw two Swallows juſt come out of the Waters, that could ſcarce ſtand, being very wet and weak, with their Wings hanging on the Ground; and that he hath obſerved the Swallows to be often weak for ſome Days after their Appearance.

(*e*) As *Swallows* are well accommodated for long Flights, by their long Wings, ſo are *Quails* by the Strength of their *pectoral Muſcles*, by the Breadth of their Wings, *&c.* For Quails have but ſhort Wings for the Weight of their Body; and yet they fly from us into warmer Parts againſt Winter, and to us in Spring, croſſing our Seas. So divers Travellers tell us, they croſs the *Mediterranean* twice a Year, flying from *Europe* to *Africa*, and back again: Thus *Bellonius*, in Mr. *Willughby*, ſaith, *When we ſailed from* Rhodes *to* Alexandria *of* Egypt, *many* Quails *flying from the North towards the South, were taken in our Ship; whence I am verily perſuaded, that they ſhift Places: For formerly alſo, when I ſailed out of the Iſle of* Zant *to* Morea, *or* Negropont, *in the Spring Time, I had obſerved* Quails *flying the contrary Way, from South to North, that they might abide there all Summer. At which Time alſo, there were a great many taken in our Ship.* Ornith. p. 170.

CHAP.

CHAP. IV.

Of the Incubation of Birds.

ANother Thing relating to the State of this Tribe of Animals, is their *Incubation*.

And firſt, the *Egg* itſelf deſerves our Notice. Its Parts within, and its cruſty Coat without, are admirably well fitted for the Buſineſs of Incubation. That there ſhould be one Part provided for the Formation of the Body *(a)*, before its *Exit* into the World, and another for its Nouriſhment, after it is come into the World, till the Bird is able to ſhift for, and help itſelf; and that theſe Parts ſhould be ſo accurately braced, and kept in due Place *(b)*, is certainly a deſigned, as well as curious Piece of Workmanſhip.

And

(a) The Chicken is formed out of, and nouriſhed by, the White alone, till it be grown Great. The Yolk ſerves for the Chicken's Nouriſhment, after it is well grown, and partly alſo after it is hatched. For a good Part of the Yolk remains after Excluſion, being received into the Chicken's Belly; and being there reſerved, as in a Store-houſe, is by the [Appendicula, *or* Ductus Inteſtinalis,] *as by a Funnel, conveyed into the Guts, and ſerves inſtead of Milk,* &c. Willughby's Ornith. lib. i. cap. 3. *Ipſum animal ex albo liquore Ovi corporatur. Cibus ejus in luteo eſt.* Plin. lib. x. cap. 53.

Ariſtotle ſaith, *The long ſharp Eggs bring Females; the round ones, with a larger Compaſs at the ſharper End, Males.* Hiſt. An. lib. vi. cap. 2. After which, he tells us of a Sot at *Syracuſe*, that ſat Drinking ſo long, till Eggs were hatched, as alſo of the Cuſtom of *Egypt*, of hatching Eggs in Dunghills.

(b) As the Shell and Skin keep the Yolk and two Whites together; ſo each of the Parts (the Yolk and inner White at leaſt,)

And then as to the Act itſelf of *Incubation*, What a prodigious Inſtinct is it in all, or almoſt all the ſeveral Species of Birds, that they, and only they, of all Creatures, ſhould betake themſelves to this very Way of Generation? How ſhould they be aware that their Eggs contain their Young, and that their Production is in their Power (*c*)? What ſhould move them to betake themſelves to their Neſts, and there with Delight and Patience to abide the due Number of Days? And when their Young are gotten into the World, I have already ſhewn how admirable their Art, their Care, and Στοργὴ is in bringing them up until, and only until, they are able to ſhift for themſelves.

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leaſt,) are ſeparated by Membranes, involving them. At each End of the Egg is a Treddle, ſo called, becauſe it was formerly thought to be the Sperm of the Cock. *But the Uſe of theſe* (ſaith Dr. *Harvey, in Willugb. Ornith.* cap. 3.) *is to be, as it were, the Poles of this Microcoſm, and the Connections of all the Membranes twiſted and knit together, by which the Liquors are not only conſerved, each in its Place, but do alſo retain their due Poſition one to another.* This, although in a great Meaſure true, yet doth not come up to what I have myſelf obſerved; for I find that theſe *Chalazæ*, or *Treddles*, ſerve not barely to keep the Liquors in their Place, and Poſition to one another; but alſo to keep one and the ſame Part of the Yolk uppermoſt, let the Egg be turned nearly which Way it will: which is done by this Mechaniſm: The *Chalazæ* are ſpecifically lighter than the Whites, in which they ſwim; and being braced to the Membrane of the Yolk, not exactly in the *Axis* of the Yolk, but ſomewhat out of it, cauſeth one Side of the Yolk to be heavier than the other; ſo that the Yolk being by the *Chalazæ* made buoyant, and kept ſwimming in the Midſt of two Whites, is by its own heavy Side kept with the ſame Side always uppermoſt; which uppermoſt Side, I have ſome Reaſon to think, is that on which the *Cicatricula* lies; that being commonly uppermoſt in the ſhell, eſpecially in ſome Species of Eggs more, I think, than others.

(*c*) All Birds lay a certain Number of Eggs, or nearly that Number, and then betake themſelves to their Incubation; but if their Eggs be withdrawn, they will lay more. Of which ſee Mr. *Ray's Wiſdom of God*, p. 137.

And laſtly, when almoſt the whole Tribe of Birds do thus, by incubation, produce their Young, it is a wonderful Deviation, that ſome few Families only, ſhould do it in a more novercal Way *(d)*, without any Care or Trouble at all, only by laying their Eggs in the Sand, expoſed to the Heat and Incubation of the Sun. Of this the Holy Scripture itſelf gives us an Inſtance in the Oſtrich: Of which we have an Hint, *Lam.* iv. 3. *The Daughter of my People is become cruel, like the Oſtriches in the Wilderneſs.* This is more plainly expreſſed in *Job* xxxix. 14, 15, 16, 17. [The Oſtrich] *leaveth her Eggs in the Earth, and warmeth them in the Duſt, and forgetteth that the Foot may cruſh them, or that the wild Beaſt may break them. She is hardened againſt her Young ones, as though they were not hers: Her Labour is in vain, without Fear. Becauſe* GOD *hath deprived her of Wiſdom, neither hath he imparted unto her Underſtanding.* In which Words I ſhall take Notice of three Things: 1. Of this anomalous Way of Generation. It is not very ſtrange, that no other Incubation but that of the Sun, ſhould produce their Young; but it is very odd and won-

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(d) The *Tabon* is a Bird no bigger than a Chicken, but is ſaid to lay an Egg larger than a Gooſe's Egg, and bigger than the Bird itſelf. Theſe they lay a Yard deep in the Sand, where they are hatched by the Warmth of the Sun; after which they creep out, and get to Sea for Proviſions. *Navarette's Account of China, in Collect. of Voyages*, vol. i. This Account is, in all Probability, borrowed from *Nieremberg*, or *Hernandez* (that copied from him), who call this Bird by the Name of *Daie*, and its Eggs *Tapun*, not the Bird itſelf, as *Navarette* doth. But my Friend Mr. *Ray* ſaith of it, *Hiſtoria iſthæc proculdubio fabuloſa & falſa eſt. Quamvis enim Aves nonnullæ maxima ova pariunt, ut v. g.* Alkæ, Lomwiæ, Anates, Arcticæ, *&c. hujuſmodi tamen unum duntaxat, non plura, ova ponunt antequam incubent: nec ullam in rerum naturâ avem dari exiſtimo cujus ova albumine careant. Cum Albumen præcipua ovi pars ſit, quodque primum fœtui alimentum ſubminiſtrat.* Raii Synop. Av. Meth. p. 155.

derful that any one Species ſhould vary from all the reſt of the Tribe. But above all, 2. The ſingular Care of the Creator, in this Caſe, is very remarkable, in ſupplying ſome other Way the Want of the Parent-Animals Care and Στοργὴ (e), ſo that the Young ſhould, notwithſtanding, be bred up in thoſe large and barren Deſerts of *Arabia* and *Africa*, and ſuch like Places where thoſe Birds dwell, the moſt unlikely and unfitting (in all human Opinion) to afford Suſtenance to young helpleſs Creatures; but the fitteſt therefore to give Demonſtrations of the Wiſdom, Care, and eſpecial Providence of the infinite Creator and Conſervator of the World. 3. The laſt Thing I ſhall Remark is, That the Inſtincts of Irrational Animals, at leaſt of this ſpecified in the Text, is attributed to God. For the Reaſon the Text gives why the *Oſtrich is hardened againſt her Young Ones, as though they were not hers*, is, *Becauſe GOD hath deprived her of Wiſdom, and not imparted Underſtanding to her*; i. e. he hath denied her that Wiſdom, he hath not imparted that Underſtanding, that Στοργὴ, that natural Inſtinct to provide for, and nurſe up her Young, that moſt other Creatures of the ſame, and other Tribes, are endowed with.

Thus I have diſpatched what I intended to inſiſt upon concerning the State of this Set of Animals; of which, as alſo of their admirable Inſtincts, a great deal more might deſerve our eſpecial Obſervation; particularly the admirable Curioſity, Art, and Variety of Nidification *(f)*, uſed among the various Species of Birds; the great Sagacity, and many Artifices uſed by them in the Inveſtigation and Capture of their Prey *(g)*, the due Proportion of the more and leſs uſeful, the Scarcity of the Voracious and Pernicious, and the Plenty of the Manſuete and Uſeful *(h)*. Alſo the Variety of their Motion and Flight might deſerve Conſideration, the Swiftneſs of ſuch whoſe Food is to be ſought in far diſtant Places, and different Seaſons *(i)*; the ſlower Motion, and ſhort Flights, of others more Domeſtick; and even the Aukwardneſs of ſome others to Flight, whoſe Food is near at hand, and to be gotten without any great Occaſion of Flight *(k)*. Theſe, and divers other ſuch like Things as theſe, I ſay, I might have ſpoken more largely unto; but I ſhall paſs them by with only a bare Mention, having already taken Notice of them in the Company of other Matters of the like Nature, and manifeſted them to be Acts of excellent Deſign, Wiſdom, and Providence in the great Creator.

(e) *The Eggs of the Oſtrich being buried in the Sand, are cheriſhed only by the Heat of the Sun, till the Young be excluded: For the Writers of Natural Hiſtory do generally agree, that the old Birds, after they have laid and covered their Eggs in the Sand, forſake them, and take no more Care of them.* Willugh. Ornith. lib. ii. cap. 8. ſect. 1.

But there is another *Oſtrich* [of *America*] which *Acaret* tells us of, that takes more Care of her Young, by carrying four of her Eggs, a little before ſhe hatcheth, to four Parts of her Neſt, there to breed Worms for Food for her Young. *Acaret*'s *Diſc. in Philoſ. Tranſ.* N° 89.

(f) See *Book* IV. *Chap.* 13.

(g) See *Book* IV. *Chap.* 11. and 14.

(h) See *Book* IV. the Beginning of *Chap.* 10.

(i) See *Book* IV. *Chap.* 8.

(k) The *Colymbi*, or *Douckers*, having their Food near at hand in the Waters, are remarkably made for Diving therein. Their Heads are ſmall, Bills ſharp-pointed, Wings ſmall, Legs flat and broad, and placed backward, and nearer the Tail than in other Birds; and laſtly, their Feet, ſome are whole-footed, ſome cloven-footed, but withal fin-toed. *Vide Willugh. Ornith.* lib. iii. ſect. 5.

CHAP. V.

The Concluſion.

AND now, if we reflect upon the whole Matter, we ſhall here find another large Tribe of the Creation, abundantly ſetting forth the Wiſdom and Glory of their great Creator. We praiſe the Ingenuity and Invention of Man, for the Contrivance of various pneumatick Engines; we think them witty, even for their unſucceſsful Attempts to ſwim in, and ſail through that ſubtle Element the Air; and the curious Mechaniſm of that Artiſt is had in Remembrance, and praiſe to this Day, who made a Dove, or an *Eagle (a)* to fly but a ſhort Space. And is not therefore all imaginable Honour and Praiſe due to that infinite Artiſt, that hath ſo admirably contrived and made all the noble Variety of Birds; that hath with ſuch incomparable Curioſity and Art, formed their Bodies from Head to Tail, without and within, that not ſo much as any Muſcle, or Bone, no, not even a Feather *(b)*, is unartificially made, miſplaced, redundant, or defective, in all the ſeveral Families of this large Tribe? But every Thing is ſo incomparably performed, ſo nicely fitted up for Flight, as to ſurpaſs even the Imitation of the moſt ingenious Artificer among mortal rational Beings.

(a) See *Book* V. *Chap.* 1. *Note (aa)*.

(b) *Deus non ſolum Angelum, & Hominem, ſed nec exigui & contemptibilis animantis viſcera, nec Avis pennulam, nec Herbæ floſculum, nec Arboris folium, ſine ſuarum partium convenientiâ dereliquit.* Auguſtin. de Civ. Dei, lib. v. cap. xi.

BOOK VIII.

Of INSECTS and REPTILES.

CHAP. I.

Of Inſects in general.

HAVING diſpatched that Part of the Animal World, which uſed to be accounted the more perfect, thoſe Animals ſtiled leſs perfect, or imperfect, will next deſerve a Place in our *Survey*, becauſe, when ſtrictly inquired into, we ſhall find them to be ſo far from deſerving to be accounted mean and deſpicable Parts of the Creation, owing their Original and Production to Putrefactions, *&c.* as ſome have thought, that we ſhall find them, I ſay, noble, and moſt admirable Works of GOD. For, as the famous Natural Hiſtorian, *Pliny* (*a*), prefaceth his *Treatiſe of Inſects*, to prevent the Reproach of condeſcending (as might be thought) to ſo mean a Subject: *In great Bodies*, ſaith he, *Nature had a large and eaſy ſhop to work upon obſequious*

(*a*) *In magnis ſiquidem corporibus, &c.* Plin. Nat. Hiſt. lib. xi. cap. 2.

Matter; whereas, in theſe ſo ſmall, and as it were no Bodies, what Footſteps of Reaſon, what Power, what great Perfection is there? Of this having given an Inſtance or two of the exquiſite Senſes, and curious Make of ſome Inſects (*b*), he then goes on, *We admire,* ſaith he, *the turrigerous Shoulders of Elephants, the lofty Necks and Creſts of others; but,* ſaith he, *the Nature of Things is never more complete than in the leaſt Things.* For which Reaſon he intreats his Readers (as I do mine) *that becauſe they ſlighted many of the Things themſelves which he took Notice of, they would not therefore diſdainfully condemn his Accounts of them, ſince,* ſaith he, *in the Contemplation of Nature, nothing ought to ſeem Superfluous.*

Thus that eminent Naturaliſt hath made his own, and my Excuſe too: the Force and Verity whereof will farther appear, by what I ſhall ſay of theſe Animals, which (as deſpicable as they have been, or perhaps may be thought) we ſhall find as exquiſitely contrived, and curiouſly made for that Place and Station they bear in the World, as any other Part of the Animal World. For if we conſider the innumerable Variety of their Species, the prodigious Numbers of Individuals, the Shape and

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(*b*) *Ubi tot ſenſus collocavit in Culice? Et ſunt alia dictu minora. Sed ubi Viſum in eo prætendit: Ubi Guſtatum applicavit? Ubi Odoratum inſeruit? Ubi verò truculentam illam & portione maximam vocem ingeneravit? Quâ ſubtilitate Pennas adnexuit? prælongavit Pedum crura? Diſpoſuit jejunam Caveam, uti Alvum? Avidam Sanguinis, & potiſſimum humani, ſitim, accendit? Telum verò perfodiendo tergori, quo ſpiculavit ingenio? Atque ut in capaci cum cerni non poſſit exilitas, ita reciprocâ geminavit arte, ut fodiendo acuminatum pariter ſorbendoque fiſtuloſum eſſet. Quos Teredini ad perforanda Robora cum ſono teſte dentes affixit? Potiſſimumque ĕ ligno cibatum fecit: Sed turrigeros Elephantorum miramur humeros, Taurorumque colla, & truces in ſublime jactus, Tigrium rapinas, Leonum jubas, cùm rerum natura nuſquam magis quàm in minimis, tota ſit.* Plin. ibid.

Make of their little Bodies, and every Part thereof, their Motion, their Inſtincts, their regular Generation and Production; and, to name no more, the incomparable Beauty and Luſtre of the Colours of many of them, what more admirable and more manifeſt Demonſtration of the infinite Creator, than even this little contemned Branch of the Animal World? But let us take a ſhort View of Particulars.

CHAP. II.

Of the Shape and Structure of Inſects.

LET us begin with the Shape and Fabrick of their Bodies: Which although it be ſomewhat different from that of Birds, being particularly, for the moſt Part, not ſo ſharp before, to cut and make way thro' the Air, yet it is better adapted to their Manner of Life. For conſidering that there is little Neceſſity of long Flights, and that the Strength and Activity of their Wings doth much ſurpaſs the Reſiſtance their Bodies meet with from the Air, there was no great Occaſion their Bodies ſhould be ſo ſharpened before. But the Condition of their Food, and the Manner of gathering it, together with the great Neceſſity of accurate Viſion by that admirable Proviſion made for them by the reticulated *Cornea* of their Eyes; theſe Things, I ſay, as they required a larger Room, ſo were a good Occaſion for the Largeneſs of the Head, and its Amplitude before. But for the Reſt of their Body, all is well made, and nicely poiſed for their Flight, and every other of their Occaſions.

And as their *Shape*, ſo the *Fabrick* and *Make* of their Bodies is no leſs accurate, admirable, and ſingular; not built throughout with Bones, and covered with Fleſh and Skin, as in moſt other Animals; but covered with a curious Mail of a middle Nature (*a*), ſerving both as Skin and Bone too, for the Shape, as well as Strength and Guard, of the Body; and as it were on Purpoſe to ſhew, that the great Contriver of Nature is not bound up to one Way only.

(*a*) *Inſecta non videntur Nervos habere, nec Oſſa, nec Spinas, nec Cartilaginem, nec Pinguia, nec Carnes, nec Cruſtam quidem fragilem, ut quædam marina, nec quæ jure dicatur Cutis: ſed mediæ cujuſdam inter omnia hæc naturæ corpus, &c.* Plin. Nat. Hiſt. lib. xi. cap. 4.

CHAP. III.

Of the Eyes and Antennæ of Inſects.

TO this laſt-mentioned Guard, we may add, that farther Guard provided in the *Eyes* and *Antennæ*. The Structure of the Eye, is, in all Creatures, an admirable Piece of Mechaniſm; but that obſervable in the Eyes of Inſects ſo peculiar, that it muſt needs excite our Admiration; Fenced with its own Hardneſs, yea, even its own accurate Viſion, is a good Guard againſt external Injuries; and its *Cornea*, or outward Coat, all over beſet with curious, tranſparent, lenticular (*a*) Inlets, enabling

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(*a*) The *Cornea* of Flies, Waſps, &c. are ſo common an Entertainment with the Microſcope, that every body knows it is a curious Piece of Lattice-work. In which this is remarkable, abling thoſe Creatures to ſee (no doubt) very accurately every Way, without any interval of Time or Trouble to move the Eye towards Objects.

And as for the other Part, the *Antennæ*, or *Feelers*, whatever their Uſe may be in cleaning the Eyes, or other ſuch like Uſe; they are, in all Probability, a good Guard to the Eyes and Head, in their Walk and Flight, enabling them, by the Senſe of Feeling, to diſcover ſuch Annoyances, which by their Proximity may perhaps eſcape the Reach of the Eyes and Sight *(b)*. Beſides which, they are a curious

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able, that every *Foramen* is of a lenticular Nature; ſo that we ſee Objects through them topſey-turvey, as through ſo many convex Glaſſes: Yea, they become a ſmall Teleſcope, when there is a due focal Diſtance between them and the *Lens* of the Microſcope.

This lenticular Power of the *Cornea*, ſupplies (as I imagine) the Place of the Cryſtalline, if not of the Vitreous Humour too, there being neither of thoſe Humours that I could ever find, (although for Truth ſake, I confeſs I have not been ſo diligent as I might in this Enquiry;) but inſtead of *Humours* and *Tunicks*, I imagine that every *Lens* of the *Cornea* hath a diſtinct Branch of the *Optic Nerve* miniſtring to it, and rendering it as ſo many diſtinct Eyes. So that as moſt Animals are binocular, Spiders for the moſt Part octonocular, and ſome, (as Mr. *Willughby* thought, *Raii Hiſt. Inſect.* p. 12.) ſenocular; ſo Flies, *&c.* are multocular, having as many Eyes as there are Perforations in their *Corneæ*. By which Means, as other Creatures are obliged to turn their Eyes to Objects, theſe have ſome or other of their Eyes ready placed towards Objects, nearly all round them: Thus particularly it is in the *Dragon-Fly, (Libella,)* the greateſt Part of whoſe Head is poſſeſſed by its Eyes. Which is of excellent Uſe to that predatious Inſect, for the ready ſeeing and darting at ſmall Flies all round it, on which it preys.

(b) It is manifeſt, that Inſects clean their Eyes with their Fore-legs, as well as *Antennæ*. And conſidering that as they walk along, they are perpetually feeling, and ſearching before them, with their *Feelers*, or *Antennæ*; therefore I am apt to think, that beſides wiping and cleaning the Eyes, the Uſes here named may be admitted. For as their Eyes are immoveable, ſo that no Time is required for the turning their Eyes

curious Piece of Workmanſhip, and in many, a very beautiful Piece of *(c)* Garniture to the Body.

Eyes to Objects; ſo there is no Neceſſity of the *Retina*, or *Optic Nerve*, being brought nigher unto, or ſet farther off from the *Cornea*, (which would require Time,) as it is in other Animals: But their *Cornea* and *Optic Nerve*, being always at one and the ſame Diſtance, are fitted only to ſee diſtantial Objects, but not ſuch as are very nigh: Which Inconvenience the *Feelers* obviate, leſt it ſhould be prejudicial, in occaſioning the Inſect to run its Head againſt any thing.

And that this, rather than the wiping the Eyes, is the chief Uſe of the *Feelers*, is farther manifeſt from the *Antennæ* of the *Fleſh Fly*, and many other Inſects, which are ſhort, and ſtrait, and incapable of being bent unto, or extended over the Eyes: As alſo from others enormouſly long, ſuch as thoſe of the *Capricorni*, or *Goat-chafers*, the *Cadew-Fly*, and divers others, both Beetles and Flies.

(c) The lamellated *Antennæ* of ſome, the clavellated of others, the neatly articulated of others, the feathered and divers other Forms of others, of the *Scarab*, *Papilionaceous Gnat*, and other Kinds, are ſurprizingly beautiful, when viewed through a Microſcope. And in ſome, thoſe *Antennæ* diſtinguiſh the Sexes: As in the *Gnat-kind*, all thoſe with Tufts, Feathers, and Bruſh-horns, are Males; thoſe with ſhort, ſingle-ſhafted *Antennæ*, are Females.

CHAP. IV.

Of the Parts and Motion of Inſects.

FROM the Head, paſs we to the Members, concerned in their Motion. And here we have a copious Subject, if I was minded to expatiate. I might take Notice of the admirable Mechaniſm in thoſe that creep; the curious Oars in thoſe amphibious Inſects that ſwim and walk *(a)*; the incom-

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(a) All the Families of *Hydrocanthari*, *Notonecti*, &c. have their hindmoſt Legs made very nicely, with commodious Joints

incomparable Proviſion made in the Feet of ſuch as walk, or hang upon ſmooth Surfaces *(b)*; the great Strength and Spring in the Legs of ſuch as leap *(c)*; the ſtrong and well-made Feet and Talons of ſuch as dig *(d)*: And, to name no more, the admirable Faculty of ſuch as cannot fly, to convey themſelves with Speed and Safety, by the Help of their Webs *(e)*, or ſome other Artifice, to make their

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Joints flat, and Briſtles on each Side towards the End, ſerving for Oars to ſwim; and then nearer the Body, are two ſtiff Spikes, to enable them to walk, when Occaſion is.

(b) I might here name divers Flies, and other Inſects, who, beſides their ſharp hooked Nails, have alſo ſkinny Palms to their Feet, to enable them to ſtick on Glaſs, and other ſmooth Bodies, by Means of the Preſſure of the Atmoſphere. But becauſe the Example will illuſtrate another Work of Nature, as well as this, I ſhall chuſe a ſingular Piece of Mechaniſm, in one of the largeſt Sorts of *Hydrocanthari*. Of theſe large ones there are two Sorts, one largeſt, all black, with *Antennæ* handſomely emboſſed at the Ends. The other ſomewhat leſſer, hardly ſo black, with capillary *Antennæ*; the Forehead, Edges of the *Vaginæ*, and two Rings on the *Thorax*, of a tawney Colour. The Female hath *Vaginæ*, prettily furrowed, the Male ſmooth. But that which is moſt to our Purpoſe in this Male, is a Flap, or hollowiſh Cap near the middle Joint of the fore Legs, which, when clapped on the Shoulders of the Female *in Coitu*, ſticks firmly thereon: After the Manner as I have ſeen Boys carry heavy Stones, with only a wet Piece of Leather clapped on the Top of the Stone.

(c) Thus *Graſhoppers* and *Crickets* have brawney ſtrong Thighs, with long, ſlender, but ſtrong Legs, which enable them to leap with great Agility and Strength.

(d) I have wondered to ſee with what great Quickneſs, Art, and Strength, many *Veſpæ Ichneumons*, *Wild Bees*, and *Beetles*, perforate the Earth, yea, even Wood itſelf: But the moſt remarkable Animal in this Way, is the *Mole-Cricket*, in *Book* IV. *Chap.* 13. *Note (s)*.

(e) I have with Pleaſure often ſeen Spiders dart out their Webs, and ſail away by the Help thereof. For the Manner of which ſee Mr. *Lowthorp's Abridgment*, vol. ii. p. 794. from Dr. *Liſter* and Dr. *Hulſe*, who both claimed the Diſcovery thereof. And both do ſeem to have hit thereupon, without any Foreknowledge of what each other hath diſcovered, as is ſaid

their Bodies lighter than the Air (*f*): Theſe, and a Multitude of other ſuch like Things as theſe, I

might,

ſaid in the laſt cited Place, and as I more particularly find by Mr. *Ray's Philoſ. Letters,* printed *anno* 1718, p. 95, &c. By which alſo I find, the two ingenious Doctors were very modeſt in their Claims, and very amicable in the Matter. In one of Dr. *Liſter's* to Mr. *Ray,* he thinks there is a fair Hint of the Darting of Spiders in *Ariſtot. Hiſt. An.* lib. ix. cap. 39. and in *Pliny,* lib. xi. cap. 24. But for their Sailing, that the Ancients are ſilent of, and he thinks it was ſeen firſt by him. And in another Letter, *Jan.* 20, 1670, ſpeaking of the Height Spiders are able to fly, he ſaith, *The laſt* October, &c. *I took Notice that the Air was very full of Webs, I forthwith mounted to the Top of the higheſt Steeple on the Minſter* [in York,] *and could thence diſcern them yet exceeding high above me. Some that fell, and were entangled upon the Pinnacles, I took, and found them to be* Lupi, *which Kind ſeldom or never enter Houſes, and cannot be ſuppoſed to have taken their Flight from the Steeple.*

(*f*) There are, (I imagine,) divers Animals, as well as Spiders, that have ſome Way of Conveyance, as little known to us as that of Spiders formerly was. Thus the *Squillulæ, Pulices Arboreſcentes,* and *microſcopical Animalcules* of the ſtagnating Waters, ſo numerous in them as to diſcolour ſometimes the Waters, and make them look as if they were tinged Red, Yellow, or Green, or covered with a thick green Scum; all which is nothing but Animalcules of that Colour. That theſe Creatures have ſome Way of Conveyance, I conclude, becauſe moſt ſtagnating Waters are ſtocked with them, new Pits and Ponds, yea, Holes and Gutters on the Tops of Houſes and Steeples. That they are not bred there by æquivocal Generation, every ingenious, conſidering Philoſopher will grant; that they have not Legs for travelling ſo far, is manifeſt from Inſpection: And therefore I am apt to think, that they have ſome Faculty of inflating their Bodies, or darting out Webs, and making their Bodies buoyant, and lighter than Air; or their Bodies, when dry, may be lighter than Air, and ſo they can ſwim from Place to Place; or the Eggs of ſuch as are oviparous, may be light enough to float in the Air. But then the viviparous (as my late ingenious Friend, Mr. *Charles King,* ſhewed me the *Pulices Aquat. Arboreſ.* are; theſe, I ſay,) cannot be this Way accounted for. The Cauſe of theſe latter Suſpicions was, that, in the Summer Months I have ſeen the *Pulices Arboreſ.* and the green Scum on the Waters, (nothing but Animalcules, as I ſaid,) lie in a manner dry on the Surface of the Waters; at which Time (as I have ſhewn in *Book* IV. *Chap,*

11,

might, I ſay, take Notice of, as great Evidences of the infinite Creator's Wiſdom: But leſt I ſhould be too tedious, I will confine my Obſervations to the Legs and Wings only. And theſe, at firſt View, we find to be incomparably fitted up for their intended Service, not to over-load the Body, nor in the leaſt to retard it; but to give it the moſt proper and convenient Motion. What, for Example, can be better contrived, and made for this Service, than the Wings? Diſtended and ſtrengthened by the fineſt Bones, and theſe covered with the fineſt and lighteſt Membranes, ſome of them adorned with neat and beautiful Feathers *(g)*; and many of them provided with the fineſt Articulations, and Foldings, for the Wings to be withdrawn, and neatly laid up in their *Vaginæ*, and Caſes, and again readily extended for Flight *(h)*.

And then for the Poiſing of the Body, and keeping it upright, and ſteady in Flight, it is an admirable Artifice and Proviſion for this Purpoſe; in

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11. *Note (n)*, thoſe Animalcules copulate; and, perhaps, they may at the ſame Time change their Quarters, and ſeek out new Habitations for their numerous Offspring, as well as themſelves.

(g) It is well known to all Perſons any way converſant in microſcopical Obſervations, that theſe elegant Colours of *Moths*, and *Butterflies*, are owing to neat and well made Feathers, ſet with great Curioſity and Exactneſs in Rows, and good Order.

(h) All that have *Elytra*, *Scarabs*, (who have whole *Elytra*, or reaching to the *Podex*, or the Ἡμικολεόπτεροι, ſuch as *Earwigs*, and *Staphilini* of all Sorts,) do, by a very curious Mechaniſm, extend and withdraw their membranaceous Wings, (wherewith they chiefly fly;) and it is very pretty to ſee them prepare themſelves for Flight, by thruſting out, and unfolding their Wings, and again withdraw thoſe Joints, and neatly fold in the Membranes, to be laid up ſafely in their *Elytra* or Caſes. For which Service the Bones are well placed, and the Joints miniſtring thereunto are accurately contrived, for the moſt compendious, and commodious folding up the Wings.

ſome, by four Wings *(i)*; and in ſuch as have but two, by Pointels, and Poiſes placed under the Wings, on each Side the Body.

And laſtly, It is an amazing Thing to reflect upon the ſurprizing Minuteneſs, Art, and Curioſity of the *(k)* Joints, the Muſcles, the Tendons, the Nerves, neceſſary to perform all the Motions of the Legs, the Wings, and every other Part. I have already mentioned this in the larger Animals; but to conſider, that all theſe Things concur in minute Animals, even in the ſmalleſt Mite; yea, the Animalcules, that (without good Microſcopes,) eſcape our Sight; to conſider, I ſay, that thoſe minuteſt Animals have all the Joints, Bones, Muſcles, Tendons, and Nerves, neceſſary to that briſk and ſwift Motion that many of them have, is ſo ſtupendous a Piece of curious Art *(l)*, as plainly manifeſteth the

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(i) For the keeping the Body ſteady and upright in Flight, it generally holds true, (if I miſtake not,) that all bipennated Inſects have *Poiſes* joined to the Body, under the hinder Part of their Wings; but ſuch as have four Wings, or Wings with *Elytra*, none. If one of the Poiſes, or one of the leſſer auxiliary Wings be cut off, the Inſect will fly as if one Side overbalanced the other, until it falleth on the Ground; ſo if both be cut off, they will fly aukwardly, and unſteadily, manifeſting the Defect of ſome very neceſſary Part. Theſe *Poiſes*, or *Pointels*, are, for the moſt part, little Balls, ſet at the Top of a ſlender Stalk, which they can move every Way at Pleaſure. In ſome they ſtand alone; in others, (as in the whole *Fleſh-Fly* Tribe,) they have little Covers or Shields, under which they lie and move. The Uſe, no doubt, of theſe *Poiſes*, and *ſecondary* leſſer Wings, is to poiſe the Body, and to obviate all the Vacillations thereof in Flight; ſerving to the Inſect, as the long Pole, laden at the Ends with Lead, doth the *Rope-dancer*.

(k) As all the parts of Animals are moved by the Help of theſe; ſo there is no doubt but the minuteſt Animals have ſuch like Parts: But the Muſcles and Tendons of ſome of the larger Inſects, and ſome of the leſſer too, may be ſeen with a Microſcope.

(l) The minute Curioſities, and inimitable Fineries, ob-

ſervable

the Power and Wiſdom of the infinite Contriver of thoſe inimitable Fineries. But having named thoſe minute Animals, why ſhould I mention only any one Part of their Bodies, when we have, in that little Compaſs, a whole and complete Body, as exquiſitely formed, and (as far as our Scrutiny can poſſibly reach,) as neatly adorned, as the largeſt Animal? Let us conſider, that there we have Eyes, a Brain, a Mouth, a Stomach, Entrails, and every other Part of an animal Body, as well as Legs and Feet; and that all thoſe Parts have each of them their neceſſary *Apparatus* of Nerves, of various Muſcles, and every other Part that other Inſects have; and that all is covered and guarded with a well-made Tegument, beſet with Briſtles, adorned with neat Imbrications, and many other Fineries. And laſtly, let us conſider in how little Compaſs all Art and Curioſity may lie,

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ſervable in thoſe leſſer Animals, in which our beſt Microſcopes diſcover no Botch, no rude ill-made Work, (contrary to what is in all artificial Works of Man,) do they not far more deſerve our Admiration, than thoſe celebrated Pieces of human Art? Such as the Cup made of a Pepper-Corn, by *Oſwald Nerlinger*, that held 1200 Ivory Cups, all gilt on the Edges, and having each of them a Foot, and yet affording Room for 400 more, in the *Ephem. Germ. T.* 1. *Addend. ad Obſ.* 13. Such alſo was *Phaëton* in a Ring, which *Galen* thus reflects upon when he ſpeaks of the Art and Wiſdom of the Maker of Animals, particularly ſuch as are ſmall: *Quanto*, ſaith he, *ipſum minus fuerit, tanto majorem admirationem tibi excitabit; quod declarant Opifices cùm in corporibus parvis aliquid inſculpant: cujus generis eſt quòd nuper quidam in Annulo Phaëtonta quatuor equis invectum ſculpſit: Omnes enim equi frænum, os, & dentes anteriores habebant, &c.* And then having taken Notice, that the Legs were no bigger than thoſe of a *Gnat*, he ſhews that their Make did not come up to thoſe of the *Gnat*; as alſo, ſaith he, *Major adhuc alia quædam eſſe videtur artis ejus, qui pulicem condidit, Vis atque Sapientia, quod, &c. Cùm igitur Ars tanta in tam abjectis animalibus appareat, — quantam ejus Vim ac Sapientiam in præſtantioribus ineſſe putabimus?* Galen. de Uſ. Part. lib. xvii. cap. 1. fin.

even in a Body many times leſs than a ſmall Grain of Sand *(m)*; ſo that the leaſt Drop of Water can contain many of them, and afford them alſo ſufficient Room to dance and friſk about in *(n)*.

Having ſurveyed as many of the Parts of Inſects as I care to take Notice of; I ſhall in the next Place ſay ſomewhat of their State, and Circumſtances of Life. And here I ſhall take Notice only of two Things, which have been only hinted at before; but will deſerve more particular Conſideration here, as being Acts of a wonderful Inſtinct; namely, Their Security of themſelves againſt Winter; and their ſpecial Care of preſerving their Species.

(m) It will in ſome Meaſure appear, how wonderfully minute ſome microſcopical Animalcules are, by what follows in the next Note. But becauſe more particular Examples would be endleſs, I ſhall refer to the Obſervations of Mr. *Leuwenhoeck* and others, in the *Philoſ. Tranſ.* and elſewhere.

(n) It is almoſt impoſſible, by Reaſon of their perpetual Motion, and changing Places, to count the Number of the Animalcules, in only a Drop of the green Scum upon Water; but I gueſs I have ſometimes ſeen not fewer than 100 friſking about in a Drop no bigger than a Pin's Head. But in ſuch a Drop of Pepper-water, a far greater Number; theſe being much leſs than thoſe.

CHAP.

CHAP. V.

The Sagacity of Inſects to ſecure themſelves against Winter.

IT is an extraordinary Act of Inſtinct and Sagacity, obſervable in the Generality of the Inſect-Tribe, that they all take Care to ſecure themſelves, and provide againſt the Neceſſities of Winter: That when the Diſtreſſes of Cold and Wet force them, they ſhould retire to warm and dry Places of Safety, is not ſtrange; but it is a prodigious Act of the infinite Conſervator's Care, to enable ſome to live in a different Kind of Inſect-State; others to live, as without Action, ſo without Food; and others that act and eat, to lay up in Summer ſufficient Proviſions againſt the approaching Winter. Some, I ſay, live in a different State; for having ſufficiently fed, nouriſhed, and bred up themſelves to the Perfection of their *Vermicular Nympha-State*, in the Summer-Months, they then retire to Places of Safety, and there throw off their *Nympha*, and put on their *Aurelia*, or *Chryſalis-State*, for all the Winter, in which there are no Occaſions for Food. This is the conſtant Method of many Families of the Inſect-Tribe *(a)*.

(a) It would be endleſs to enter into Particulars here, becauſe all the *Papilionaceous*, *Fleſh*, and *Ichneumon-Fly* Tribes, and all others that undergo the *Nympha* and *Aurelia* State, between that of the Egg and *Mature* State, (which are very numerous) appertain to this *Note*. For a Sample therefore only, I ſhall take what ſome may think a mean one, but if conſidered, deſerves our Admiration, and that is, the Saga-

But there are others, and ſome of them in their moſt perfect State too, that are able to ſubſiſt in a kind of Torpitude, or Sleeping-State, without any Food at all; by Reaſon as there is no Action, ſo no Waſte of Body, no Expence of Spirits, and therefore no need of Food *(b)*.

But for others that move and act, and need Food, it is a prodigious Inſtinct and Foreſight the Creator hath imprinted on them, to lay up ſufficient Food in Summer for the Winter's *(c)* Neceſſities and Occaſions.

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city of the *White butter-fly Caterpillar*, which having fed itſelf its due Time, then retires to Places of Security. I have ſeen great Trains of them creeping up the Walls and Poſts of the next Houſes, where, with the Help of ſome Cobweb-like Filaments, they hang themſelves to the Cielings, and other commodious Places, and then become *Aureliæ*; in which State and Places they hang ſecure from the Wet and Cold, till the Spring, and warmer Months, when they are tranſmuted into Butter-flies.

(b) I ſhall not name any of the particular Species of Inſects which live in this State, becauſe they are very numerous, but only remark two Things obſervable in their Sagacity in this Matter: 1. That they are not driven by Streſs of Weather to their Retirement, but ſeem as naturally to betake themſelves thereto, as other Animals do to Reſt and Sleep. For before the Approach of cold Weather, towards the End of Summer, we may ſee ſome Kinds of them flocking together, in great Numbers, within Doors, (as *Swallows* do a little before they leave us) as if they were making ready for their Winter's Reſt. 2. That every Species betakes itſelf to a proper convenient Receptacle; ſome under the Waters to the Bottoms of Ponds; ſome under the Earth, below the Froſts; ſome under Timber, Stone, *&c.* lying on the Ground; ſome into hollow Trees, or under the Bark, or in the Wood; ſome into warm and dry Places; and ſome into dry alone.

(c) There are not many Kinds that thus provide their Food before-hand. The moſt remarkable, are the *Ant* and the *Bee*; concerning the firſt of which, *Origen* hath this Remark, *viz. De ſolertiâ Formicarum, venturæ hyemi maturè proſpicientium, ſibique invicem ſub onere feſſis ſuccurrentium; quódque fruges arroſas condunt, ne rurſus enaſcantur, ſed per annum*

aliment

caſions. And it is very pretty to ſee with what unwearied Diligence all Hands are at Work for that Purpoſe, all the Warmer Months. Of this the Holy Scripture itſelf gives us an Inſtance in the *Ant*, calling that little Animal *exceeding wiſe*, Prov. xxx. 24. And the Reaſon is, *ver.* 25. *The Ants are a People not ſtrong, yet they prepare their Meat in the Summer.* And therefore *Solomon* ſends the Sluggard to this little contemptible Creature, to learn Wiſdom, Foreſight, Care, and Diligence, *Prov.* vi. 6, 7, 8. *Go to the Ant, thou Sluggard, conſider her Ways, and be wiſe: which having no Guide, Overſeer, or Ruler, provideth her Meat in the Summer, and gathereth her Food in the Harveſt.*

To this Scriptural Example, give me leave to anticipate, and ſubjoin an Obſervation of the farther great Wiſdom of this little Creature; and that is their unparalleled Στοργὴ, their Tenderneſs, Sagacity, and Diligence, about their Young (*d*). It

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alimento ſint, non ratiocinationem Formicarum in causâ debemus credere, ſed almam matrem Naturam bruta quoque ſic ornantem, ut etiam minimis addat ſua quædam ingenia. Orig. cont. Celſ. lib. iv.

But as for *Waſps, Hornets, Humble-Bees*, and other *Wild-Bees, Veſpæ-Ichneumons*, and divers others that carry in Materials for Neſts and Food; this is only for the Service of their Generation, for hatching their Eggs, and nouriſhing their Young, not for Supplies in Winter; for they all forſake their Neſts towards Winter, and retire to other Quarters, living (I conceive) without Food all that Time.

(*d*) *Hos vermiculos* [Formicarum Ova vulgò vocatos] *incredibili* Στοργὴ & *curâ Formicæ educant, ſummamque dant operam, ne vel tantillum, quod ſpectet eorum vermiculorum educationem atque nutritionem, omittant: quem in finem fere ſemper eoſdem ore circumportant ſecum, ne ulla eos lædet injuria. In muſeo meo nonnullas iſtius generis formicas, vitro terrâ repleto, concluſas cum Vermiculis iſtis adſervabam: ibi non ſine jucunditate ſpectabam, quo terra fieret in ſuperficie ſiccior, eo profundiùs Formicas cum fœtibus ſuis prorepere: cùm verò aquam adfunderem, viſu mirificum erat, quanto affectu, quantâ ſolicitu-*

It is very diverting, as well as admirable to ſee, with what Affection and Care they carry about their Young in their Mouths, how they expoſe themſelves to the greateſt Dangers, rather than leave their Young expoſed or forſaken; how they remove them from Place to Place in their little Hills, ſometimes to this Part, ſometimes to that, for the Benefit of convenient Warmth, and proper Moiſture; and then again withdraw, and guard them againſt Rain and Cold. Now that this great Wiſdom which the Scriptures attribute unto, and is diſcernible in, this little Animal, is owing only to the Inſtinct, or Infuſions of the great Conſervator of the World, is evident, becauſe either this Wiſdom, Thought, and Forecaſt, is an Act of the Animal itſelf, or of ſome other Being that hath Wiſdom. But the Animal being irrational, it is impoſſible

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dine, quantâ Στοργὴ *omnem in eo collocarent operam, ut fœtus ſuos ſicciore & tuto loco reponerent. Sæpiùs vidi, cùm aliquot diebus aquâ caruiſſent, atque cùm affuſo tantillo aquæ terram illam humectarem, è veſtigio à Formicis fœtus ſuos eo loci fuiſſe allatos, quos ibi diſtinctè conſpiciebam moveri atque ſugere humorem.) Multoties fui canatus, ut eos Vermiculos ipſe educarem, at ſemper conatum fefellit eventus: neque ipſas Formicarum Nymphas alimenti jam non indigas unquam ſine ipſis Formicis potui potu artificiali excludere.* J. Swammerd. Epilog. ad Hiſt. Inſect. p. 153.

Sir *Edward King*, who was very curious in examining the Generation of *Ants*, obſerves their great Care and Diligence, 1. About their Sperm, or true Eggs, which is a fine white Subſtance, like Sugar, which they diligently gather together into a Heap, when ſcattered, and on which they lie in Multitudes, (I ſuppoſe, by way of Incubation.) 2. I have obſerved, ſaith he, in Summer, that in the Morning they bring up thoſe of their Young (called Ant-Eggs) towards the Top of the Bank: So that you may from 10 in the Morning, until 5 or 6 Afternoon, find them near the Top — for the moſt Part on the South ſide the Bank. But towards 7 or 8 at Night, if it be cool, or likely to rain, you may dig a Foot deep before you can find them. *Philoſ. Tranſ.* Nº 23. or Mr. *Lowthorp*'s *Abridg.* vol. ii. p. 7, and 9.

impoſſible it can be its own Act, but muſt be derived, or received from ſome wiſe Being. And who? What can that be, but the infinite Lord, Conſervator, and Governor of all the World?

CHAP. VI.

Of the Care of Inſects about their Young.

THE other notable Inſtinct I am to treat of, is the peculiar Art and Care of the Inſect-Tribe, about the Preſervation of their Species. Here I might ſpeak of many Things, but I have occaſionally mentioned divers of them before, under ſome or other of the General Heads, and therefore ſhall fix only upon two Things relating to their ſpecial Art and Care about the Production (a) of their Young, which have not been ſo particularly ſpoken to as they deſerve.

One Thing is their ſingular Providence for their Young, in making or finding out ſuch proper Receptacles and Places for their Eggs and Seed, as that they may receive the Advantage of a ſufficient Incubation, and that the Young, when produced, may have the Benefit of proper and ſufficient Food for their Nurture and Education, till they are able to ſhift for themſelves. It is admirable to ſee with what Diligence and Care the ſeveral Species of Inſects lay up their Eggs, or Sperm, in their ſeveral proper Places; not all in the Waters, in Wood, or on Vegetables; but thoſe whoſe Subſiſtence is in the Waters *(b)*, in the Water; thoſe to whom Fleſh is a proper Food, in Fleſh *(c)*; thoſe

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(a) The Doctrine of Æquivocal Generation is at this Day ſo ſufficiently exploded by all learned Philoſophers, that I ſhall not enter the Diſpute, but take it for granted, that all Animals ſpring from other Parent Animals. If the Reader hath any Doubt about it, I refer him to Seigneur *Redi*, *de Gen. Inſect.* and Mr. *Ray's Wiſdom of God*, &c. p. 344. See alſo before, *Book* IV. *Chap.* xv. *Note (a)*.

(b) It would be endleſs to ſpecify the various Species of Inſects, that have their Generation in the Waters; and therefore I ſhall only obſerve of them, 1. That their Eggs are always laid up with great Care, and in good Order. And alſo, 2. Where proper and ſufficient Food is. 3. That in their *Nymphæ* State in the Waters, they have Parts proper for Food and Motion; and in many, or moſt of them, very different from what they have in their *Mature* State; a manifeſt Argument of the Creator's Wiſdom and Providence. For an Inſtance, ſee *Note (r).*

(c) As Seigneur *Redi* was one of the firſt that made it his Buſineſs to diſcard Anomalous Generation, ſo he tried more Experiments relating to the Vermination of Serpents, Fleſh, Fiſh, putrified Vegetables; and, in ſhort, whatever was commonly known to be the Nurſery of Maggots; more, I ſay, probably, than any one hath done ſince. And in all his Obſervations, he conſtantly found the Maggots to turn to *Aureliæ*, and theſe into *Flies*. But then, ſaith he, *Dubitare cœpi, utrùm omne hoc vermium in carne genus, ex ſolo Muſcarum ſemine, an ex ipſis putrefactis carnibus oriretur, tantoque magis confirmabar in hoc meo dubio, quanto in omnibus generationibus — ſæpiùs videram, in carnibus, antequam verminare inciperent, reſediſſe ejuſcem ſpeciei Muſcas, cujus propago poſtea naſcebatur.* Upon this he tells us, he put Fiſh, Fleſh, &c. into Pots, which he covered cloſe from the Flies with Paper, and afterwards (for the free Air ſake) with Lawn, whilſt other Pots were left open, with ſuch like Fleſh, &c. in them; that the Flies were very eager to get into the covered Pots; and that they produced not one Maggot, when the open ones had many. *Fr. Redi de Ger. Inſect.*

Among

thoſe to whom the Fruits *(d)* or Leaves of Vegetables

Among the Inſects that come from the Maggots he mentions, he names *Culices*. Now from the moſt critical Obſervations I have made, I never obſerved any Sort of *Gnat* to come from putrified Fleſh, Vegetables, or any other Thing he taxeth them with. So that either he means by *Culex*, ſome Fly that we call not by the Name of *Gnat*; or elſe their *Gnats* in *Italy* vary in their Generation from ours in *England*. For among above thirty, near forty, diſtinct Species of *Gnats* that I have obſerved about the Place where I live, I never found any to lay their Eggs in Fleſh, Fiſh, &c. but the largeſt Sort, called by *Aldrovand*, *Culices maximi*, by *Swammerdam*, *Tipulæ terreſtres*, lay their Eggs in Meadows, &c. under the Graſs; one of the larger middle Sort, in dead Beer, Yeaſt, &c. lying on the Tops, or in the Leaks of Beer-Barrels, &c. and all the reſt (as far as ever I have obſerved) lay and hatch in the Waters, as in *Note (r)*.

The Generation of the Second of theſe being akin to ſome of the foregoing Inſtances, and a little out of the Way, may deſerve a Place here. This *Gnat* lays its Eggs commonly in dead Beer, &c. as I ſaid, and probably in Vinegar, and other ſuch Liquors. Some Time after which, the Maggots are ſo numerous, that the whole Liquor ſtirreth as if it was alive; being full of Maggots, ſome larger, ſome ſmaller; the larger are the Offspring of our *Gnat*, the ſmaller, of a ſmall dark coloured Fly, tending to reddiſh, frequent in Cellars, and ſuch obſcure Places. All theſe *Maggots* turn to *Aurelia*, the larger of which, of a Tan-Colour, turn to our *Gnat*. This *Gnat* is of the unarmed Kind, having no Spear in its Mouth: Its Head is larger than that of the common *Gnats*, a longer Neck, ſhort-jointed *Antennæ*, ſpotted Wings, reaching beyond its ſlender *Alvus*; it is throughout of a brown Colour, tending to red, eſpecially in the Female: The chief Difference between the Male and Female is, (as in other *Gnats*, yea, moſt Inſects) the Male is leſs than the Female, and hath a ſlenderer Belly, and its *Podex* not ſo ſharp as the Female's is.

(d) The Inſects that infeſt Fruits, are either of the *Ichneumon-Fly* Kind, or *Phalænæ*. Plumbs, Peaſe, Nuts, &c. produce ſome or other *Ichneumon-Fly*. That generated in the *Plumb* is black, of a middle Size, its Body near three-tenths of an Inch long, its Tail not much leſs, conſiſting of three Briſtles, wherewith it conveys its Eggs into Fruits: Its *Antennæ*, or Horns, long, ſlender, recurved; its Belly longiſh, tapering,

tables are Food, are accordingly repoſited, ſome in this Fruit, ſome on this Tree (*e*), ſome on that Plant (*f*), ſome on another, and another; but conſtantly

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ſmall towards the *Thorax*; *Legs* reddiſh; *Wings* membranaceous, thin, and tranſparent, in *Numb.* 4. which is one Characteriſtick of the *Ichneumon-Fly*.

The *Peaſe Ichneumon-Fly* is very ſmall, Wings large, reaching beyond the *Podex*; *Antennæ* long; *Alvus* ſhort, ſhaped like an Heart, with the Point towards the *Anus*; it walketh and flieth ſlowly: No Tail appears as in the former; but they have one lieth hidden under the Belly, which they can at Pleaſure bend back to pierce Peaſe when they are young and tender, and other Things alſo, as I have Reaſon to ſuſpect, having met with this (as indeed the former two) in divers Vegetables.

Pears and *Apples* I could never diſcover any Thing to breed in, but only the leſſer *Phalæna*, about four-tenths of an Inch long, whitiſh underneath, greyiſh brown above, (dappled with brown Spots, inclining to a dirty Red) all but about a third Part at the End of the Wings, which is not grey, but brown, elegantly ſtriped with wavey Lines, of a Gold Colour, as if gilt; its Head is ſmall, with a Tuft of whitiſh-brown in the Forehead; *Antennæ* ſmooth, moderately long. The *Aurelia* of this Moth is ſmall, of a yellowiſh brown. I know not what Time they require for their Generation out of Boxes; but thoſe I laid up in *Auguſt*, did not become Moths before *June* following.

(*e*) There are many of the *Phalænæ*, and *Ichneumon-Fly* Tribes, that have their Generation on the Leaves, or other Parts of Trees and Shrubs, too many to be here reckoned up. The *Oak* hath many very beautiful *Phalænæ*, bred in its convolved Leaves, white, green, yellow, brown ſpotted prettily, and neatly dappled, and many more beſides; and its Buds afford a Place for Caſes, and Balls of various Sorts, as ſhall be ſhewn hereafter; its Leaves expanded, miniſter to the Germination of globular, and other ſphæroidal Balls, and flat *Thecæ*, ſome like Hats, ſome like Buttons excavated in the Middle; and divers other ſuch like Repoſitories, all belonging to the *Ichneumon-Fly* Kind. And not only the *Oak*, but the *Maple* alſo, the *White Thorn*, the *Brier*, *Privet*, and indeed almoſt every Tree and Shrub.

(*f*) And as Trees and Shrubs, ſo Plants have their peculiar Inſects. The *White Butterfly* lays its voracious Offſpring on ſtantly the ſame Family on the ſame Tree or Plant, the moſt agreeable to that Family. And as for others that require a conſtant and greater Degree of Warmth, they are accordingly provided by the Parent-Animal with ſome Place in or about the Body of other Animals; ſome in the Feathers of Birds (g); ſome in the Hair of Beaſts (h); ſome

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on Cabbage-Leaves; a very beautiful reddiſh ocellated one, its no leſs voracious black Offspring, of an horrid Aſpect, on the Leaves of Nettles; as alſo doth a very beautiful, ſmall greeniſh *Ichneumon-Fly*, in Caſes on the Leaves of the ſame Plant: And to name no more, (becauſe it would be endleſs) the beautiful *Ragwort-Moth*, whoſe upper Wings are brown, elegantly ſpotted with red, and under Wings edged with brown; theſe, I ſay, provide for their golden ringed *Erucæ* upon the *Ragwort-Plant*.

(g) Many, if not moſt Sorts of Birds, are infeſted with a diſtinct Kind of *Lice*, very different from one another in Shape, Size, *&c.* For Figures and Deſcriptions of them, I ſhall refer to *Seigneur Redi of Inſects.* See alſo *Mouſet*, lib. ii. cap. 23. Theſe Lice lay their Nits among the Feathers of the reſpective Birds, where they are hatched and nouriſhed; and as *Ariſtotle* ſaith, would deſtroy the Birds, particularly *Pheaſants*, if they did not duſt their Feathers. *Loco infra citat.*

(h) And as Birds, ſo the ſeveral Sorts of Beaſts have their peculiar Sorts of Lice; all diſtinct from the two Sorts infeſting Man: Only the *Aſs*, they ſay, is free, becauſe our *Saviour* rode upon one, as ſome think; but I preſume it is rather from the Paſſage in *Pliny*, lib. xi. cap. 33. or rather *Ariſt. Hiſt. Animal.* lib. iii. cap. 31. who ſaith, *Quibus pilus eſt, non carent eodem* [Pediculo] *excepto Aſino, qui non Pediculo tantùm, verùm etiam Redivio immunis eſt.* And a little before, ſpeaking of thoſe in Men, he ſhews what Conſtitutions are moſt ſubject to them, and inſtanceth in *Alcman* the Poet and *Pherecydes Syrius*, that died of the *Pthiriaſis*, or Lowſy Diſeaſe. For which foul Diſtemper, if Medicines are deſired, *Mouſet de Inſect.* p. 262. may be conſulted. Who in the ſame Page hath this Obſervation, *Animadverterunt noſtrates — ubi Aſores inſulas à tergo reliquerint, Pediculos confeſtim omnes tabeſcere: atque ubi eas reviſerint, iterum innumeros alios ſubitò oriri.* Which Obſervation is confirmed by Dr. *Stubs. Vide Lowth. Abridg.* vol, iii. p. 558. And many Seamen have told me the ſame.

in the very Scales of Fiſhes *(i)*; ſome in the Noſe *(k)*; ſome in the Fleſh *(l)*; yea, ſome in the very

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(i) Fiſhes, one would think, ſhould be free from Lice, by reaſon they live in the Waters, and are perpetually moving in, and bruſhing through them; but yet they have their Sorts too.

Beſides which, I have frequently found great Numbers of long ſlender Worms in the Stomachs, and other Parts of Fiſh, particularly *Codfiſh*, eſpecially ſuch as are poor; which Worms have worked themſelves deeply into the Coats and Fleſh, ſo that they could not eaſily be gotten out: So *Ariſtotle* ſaith of ſome Fiſhes, *Ballero & Tilloni Lumbricus innaſcitur, qui debilitat, &c. Chalcis vitio infeſtatur diro, ut Pediculi ſub Branchiis innati quàm multi interimant.* Hiſt. An. lib. viii. cap. 20.

(k) Of Inſects bred in the Noſe of Animals, thoſe in the Noſtrils of *Sheep* are remarkable. I have myſelf taken out not fewer at a Time than twenty or thirty rough Maggots, lying among the *Laminæ* of the Noſtrils. But I could never hatch any of them, and ſo know not what Animal they proceed from: But I have no great doubt, they are of the *Ichneumon-Fly* Kind; and not improbably of that with a long Tail, called *Triſeta*, whoſe three Briſtles ſeem very commodious for conveying its Eggs into deep Places.

I have alſo ſeen a rough whitiſh Maggot, above two Inches within the *Inteſtinum Rectum* of Horſes, firmly adhering thereto, that the hard Dung did not rub off. I never could bring them to Perfection, but ſuſpect the *Side-Fly* proceeds from it.

(l) In the Backs of *Cows*, in the Summer-Months, there are Maggots generated, which in *Eſſex* we call *Wornils*; which are firſt only a ſmall Knot in the Skin; and, I ſuppoſe, no other than an Egg laid there by ſome Inſect. By Degrees theſe Knots grow bigger, and contain in them a Maggot, lying in a purulent Matter: They grow to be as large as the End of one's Finger, and may be ſqueezed out at a Hole they have always open: They are round and rough, and of a dirty White. With my utmoſt Endeavour and Vigilance, I could never diſcover the Animal they turn into; but as they are ſomewhat like, ſo may be the ſame as thoſe in the Note before.

In *Perſia* there are very long ſlender Worms, bred in the Legs and other Parts of Men's Bodies, ſix or ſeven Yards long.

very Bowels *(m)*, and inmoſt Receſſes of the Bodies

In *Philoſ. Tranſ.* Mr. *Dent*, and Mr. *Lewis*, relate divers Examples of *Worms* taken out of the Tongue, Gums, Noſe, and other Parts, by a Woman at *Leiceſter*, which they were Eye-witneſſes of. Theſe, and divers others mentioned in the *Tranſactions*, may be ſeen together in Mr. *Lowthorp*'s *Abridg.* vol. iii. p. 132.

Narrat mihi vir fide dignus — Caſp. Wendlandt — ſe in Poloniâ, puero cuidam ruſtico duorum annorum, Vermiculum album è palpebrâ extraxiſſe, — magnitudinis Erucæ. — Similem fere huic caſum mihi [Schulzio] *& D. Segero narravit hoc, Anno* 1676. *chirurgus noſter Ant.* Statlender, *qui cuidam puero, ex Aure, extraxit Vermiculum talem, qualis in nucibus avellanis perforatis latitare ſolet, ſed paulò majorem, coloris albiſſimi; alteri minores 5 ejuſdem generis ſimiliter ex Aure: Omnes aliquot horas ſupervixerunt — Vermiculos adhuc viventes oculis noſtris vidimus.* Ephem. Germ. T. ii. Obſ. 24. ubi Vermiculi Icon. Many other Inſtances may be met with in the ſame Tome, Obſ. 147, 148, 154.

The Worms in *Deer* are mentioned often among antient Writers. *Ariſtotle* ſaith, Σκώληκας μέντοι πάντες ἔχουσιν, ἐν τῇ κεφαλῇ ζῶντας, &c. *They* [Deer] *all have live Worms in their Heads, bred under the Tongue, in a Cavity near the* Vertebra *on which the Head is placed; their Size not leſs than of the largeſt Maggots; they are bred altogether, in number about twenty.* Ariſtot. Hiſt. Animal. lib. ii. cap. 15.

To theſe Examples may be added the Generation of the *Ichneumon-Fly* in the Bodies of Caterpillars, and other *Nymphæ* of Inſects. In many of which, that I have laid up to be hatched in Boxes, inſtead of *Papillos*, &c. as I expected, I have found a great Number of ſmall *Ichneumon-Flies*, whoſe Parent-Animal had wounded thoſe *Nymphæ*, and darted its Eggs into them, and ſo made them the Foſter-Mother of its Young. More Particulars of this Way of Generation may be ſeen in the great Mr. *Willughby*'s Obſervations in *Philoſ. Tranſ.* N° 76. But concerning the farther Generation of this Inſect, I have taken Notice of other Particulars in other Places of theſe Notes.

(m) The Animals ordinarily bred in the Stomach and Guts, are the three Sorts of Worms called *Lati*, *Teretes*, and *Aſcarides*; concerning which, it would be irkſome to ſpeak in Particular, and therefore I ſhall refer to *Moufet*, lib. ii. cap. 31, 32, 33. Dr. *Tyſon*'s Anatomy of them in Mr. *Lowthorp's Abridg.* vol. iii. p. 121. *Seigneur Redi*'s *Obſ.* and others that have written of them.

And

dies of Man and other Creatures *(n)*: And as for others to whom none of theſe Methods are proper, but

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And not only *Worms*, but other Creatures alſo are ſaid to be found in the Stomach; Inſtances of which are ſo innumerable, that I ſhall only ſelect a few related by Perſons of the beſt Credit. And firſt of all, by ſome of our own Countrymen. Dr. *Liſter*, (whoſe Credit and Judgment will hardly be queſtioned) gives an Account of true *Caterpillars*, vomited up by a Boy of nine Years old; and another odd Animal by a poor Man. Mr. *Jeſſop*, (another very judicious, curious, and ingenious Gentleman,) ſaw *Hexapods* vomited up by a Girl; which *Hexapods* lived and fed for five Weeks. See *Lowth.* ib. p. 135.

And as to Foreigners, it is a very ſtrange Story (but atteſted by Perſons of great Repute,) of *Catharina Geileria*, that died in *Feb.* 1662. in the Hoſpital of *Altenburg*, in *Germany*, who for twenty Years voided by Vomit and Stool, *Toads* and *Lizards*, &c. *Ephemer. Germ. T.* 1. *Obſ.* 103. See alſo the 109th Obſervation of a Kitten bred in the Stomach, and vomited up; of Whelps alſo, and other Animals, bred in like Manner. But I fear a Stretch of Fancy might help in ſome of thoſe laſt Inſtances, in thoſe Days when ſpontaneous Generation was held, when the Philoſophers ſeem to have more ſlightly examined ſuch Appearances than now they do. But for the breeding of *Frogs* or *Toads*, or *Lacertæ Aquaticæ* in the Stomach, when their Spawn happeneth to be drank, there is a Story in the ſecond *Tome* of the *Ephem. Germ. Obſ.* 56. that favours it, *viz. In the Year* 1667, *a* Butcher's *Man going to buy ſome Lambs in the Spring, being thirſty, drank greedily of ſome ſtanding Water, which, a while after, cauſed great Pains in his Stomach, which grew worſe and worſe, and ended in dangerous Symptoms. At laſt he thought ſomewhat was alive in his Stomach, and after that, vomited up three live Toads; and ſo recovered his former Health.*

Such another Story Dr. *Sorbait* tells, and avoucheth it ſeen with his own Eyes, of one that had a Toad that came out of an Abſceſs, which came upon drinking foul Water. *Obſ.* 103.

(n) Not only in the Guts, and in the Fleſh, but in many other Parts of the Body, Worms have been diſcovered. One was voided by Urine, by Mr. *Mat. Milford*, ſuppoſed to have come from the Kidneys. *Lowth.* ibid. p. 135. More ſuch Examples *Mouſet* tells of. *Ibid.* So the *Vermes Cucur-*

but make themſelves Neſts by Perforations in the Earth, in Wood, or Combs they build, or ſuch like Ways; it is admirable to ſee with what Labour and Care they carry in, and ſeal up Proviſions,

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bitini are very common in the Veſſels in Sheeps Livers: And Dr. *Liſter* tells of them, found in the Kidney of a Dog, and thinks that the Snakes and Toads, &c. ſaid to be found in Animals Bodies, may be nothing elſe. *Lowth*. ib. p. 120. Nay, more than all this: In Dr. *Bern. Verzaſcha*'s ſixth Obſervation, there are divers Inſtances of Worms bred in the *Brain* of Man. One, a Patient of his, troubled with a violent Head-ach, and an Itching about the Noſtrils, and frequent Sneezing; who, with the Uſe of a Sneezing Powder, voided a Worm with a great deal of Snot from his Noſe. A like Inſtance he gives from *Bartholine*, of a Worm voided from the Noſe of *O. W.* which he gueſſeth was the famous *Olaus Wormius*: Another, from a Country-Woman of *Deitmarſh*; and others in *Tulpius*, *F. Hildanus*, *Schenkius*, &c. Theſe Worms he thinks are undoubtedly bred in the Brain: But what way they can come from thence, I cannot tell. Wherefore I rather think, they are ſuch Worms as are mentioned in *Note (k)*, and even that Worm that was actually found in the Brain of the *Paris Girl* (when opened) I gueſs might be laid in the *Laminæ* of the Noſtrils, by ſome of the *Ichneumon*, or other Inſect-Kind, and might gnaw its way into the Brain, through the *Os Cribiforme*. Of this he tells us from *Bartholine*, *Tandem cùm tabida obiiſſet, ſtatim aperto cranio præſentes Medici totam cerebelli ſubſtantiam, quæ ad dexterum vergit, à reliquo corpore ſejunctam, nigrâque tunicâ involutam deprehenderunt: hæc tunica rupta, latentem Vermem vivum, & piloſum, duobus punctis ſplendidis loco oculorum prodidit, ejuſdem fere molis cum reliquâ Cerebri portione, qui duarum horarum ſpatio ſupervixit.* B. Verzaſ. Obſ. Medicæ, p. 16.

Hildanus tells ſuch another Story, *viz. Filius Theod. auſt der Roulen, Avunculi mei, diuturno vexabatur dolore capitis. — Deinde febriculâ & ſternutatione exortâ, ruptus eſt Abſceſſus circa os cribroſum — & Vermis prorepſit.* By his Figure of it, the Maggot was an Inch long, and full of Briſtles. *Fabri Hildan. Cent.* 1. *Obſ.*

Galenus Wierus, (Phyſician to the *Princ. Jul. & Cleve*,) he ſaith, told him, that he had, at divers Times, found Worms in the *Gall-Bladder* in Perſons he had opened at *Duſſeldorp*. Id. ib. *Obſ.* 60.

that ſerve both for Production of their Young, as alſo for their Food and Nurture when produced *(o)*.

The other Piece of remarkable Art and Care about the Production of their Young, is their Curioſity and Neatneſs in repoſiting their Eggs, and in their Nidification.

As to the firſt of which, we may obſerve, that great Curioſity and nice Order is generally obſerved by them in this Matter. You ſhall always ſee their Eggs laid carefully and commodiouſly up *(p)*. When upon the Leaves of Vegetables, or other Material on Land, always glued thereon with Care, with one certain End lowermoſt, and with handſome Juxta-Poſitions *(q)*. Or if in the Waters, in neat and beautiful Rows oftentimes, in that ſpermatick, gelatine Matter, in which they are repoſited, and that Matter carefully tied and faſtened in the Waters, to prevent its Diſſipation *(r)*, or

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(o) See before, *Book* IV. *Chap*. 13. *Note (c)*.

(p) Some Inſects lay up their Eggs in Cluſters, as in Holes of Fleſh, and ſuch Places, where it is neceſſary they ſhould be crouded together; which, no queſtion, prevents their being too much dried up in dry Places, and promotes their hatching. But,

(q) As for ſuch as are not to be cluſtered up, great Order is uſed. I have ſeen upon the Poſts and Sides of Windows, little round Eggs, reſembling ſmall Pearl, which produced ſmall hairy Caterpillars, that were very neatly and orderly laid. And, to name no more, the *White Butterfly* lays its neat Eggs on the Cabbage Leaves in good Order, always gluing one certain End of the Egg to the Leaf. I call them neat Eggs, becauſe if we view them in a Microſcope, we ſhall find them very curiouſly furrowed, and handſomely made and adorned.

(r) By reaſon it would be endleſs to ſpecify the various Generation of Inſects in the Water, I ſhall therefore (becauſe it is little obſerved) take *Pliny*'s Inſtance of the *Gnat*, a mean and contemned Animal, but a notable Inſtance of Nature's Work, as he ſaith.

The

or if made to float, ſo carefully ſpread and poiſed as to ſwim about with all poſſible Artifice.

And as to their other Faculty, that of Nidification, whether it be exerted by boring the Earth or

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The firſt Thing conſiderable in the Generation of this Inſect is (for the Size of the Animal) its vaſt *Spawn*, being ſome of them above an Inch long, and half a quarter Diameter; made to float in the Waters, and tied to ſome Stick, Stone, or other fixed Thing in the Waters, by a ſmall Stem or Stalk. In this gelatine, tranſparent Spawn, the Eggs are neatly laid; in ſome Spawns in a ſingle, in ſome in a double ſpiral Line, running round from End to End, as in *Fig.* 9, and 10; and in ſome tranſverſly, as *Fig.* 8.

When the Eggs are, by the Heat of the Sun, and Warmth of the Seaſon, hatched into ſmall Maggots, theſe Maggots deſcend to the Bottom, and by means of ſome of the gelatine Matter of the Spawn (which they take along with them) they ſtick to Stones, and other Bodies, at the Bottom, and there make themſelves little Caſes or Cells, which they creep into and out at Pleaſure, until they are arrived to a more mature *Nympha State*, and can ſwim about here and there, to ſeek for what Food they have Occaſion; at which Time they are a Kind of red Worms, above half an Inch long, as in *Fig.* 11.

Thus far this mean Inſect is a good Inſtance of the Divine Providence towards it. But if we farther conſider, and compare the three States it undergoes after it is hatched, we ſhall find yet greater Signals of the Creator's Management, even in theſe meaneſt of Creatures. The three States I mean, are its *Nympha-Vermicular* State, its *Aurelia*, and *Mature* State, all as different as to Shape and Accoutrements, as if the Inſect was three different Animals. In its *Vermicular* State, it is a red Maggot, as I ſaid, and hath a Mouth and other Parts accommodated to Food: In its *Aurelia* State, it hath no ſuch Parts, becauſe it then ſubſiſts without Food; but in its *Mature, Gnat* State, it hath a curious well-made Spear, to wound and ſuck the Blood of other Animals. In its *Vermicular* State, it hath a long Worm-like Body, and ſomething analogous to Fins or Feathers, ſtanding erect near its Tail, and running parallel with the Body, by means of which reſiſting the Waters, it is enabled to ſwim about by Curvations, or flapping its Body ſide-ways, this Way and that, as in *Fig.* 12.

or Wood, or building themſelves Cells *(s)*, or ſpinning and weaving themſelves Caſes and Webs, it is all a wonderful Faculty of thoſe poor little Animals, whether we conſider their Parts wherewith they work, or their Work itſelf. Thus thoſe who perforate the Earth, Wood, or ſuch like, they have their Legs, Feet, Mouth, yea, and whole Body accommodated to that Service; their Mouth exactly formed to gnaw thoſe handſome round Holes, their Feet as well made to ſcratch and bore *(t)*, and their Body handſomely turned and fitted to follow. But for ſuch as build or ſpin themſelves Neſts, their Art juſtly bids Defiance to the moſt ingenious Artiſt among Men, ſo much as tolerably to copy the nice Geometrical Combs of ſome *(u)*, the Earthen Cells of others, or the Webs, Nets, and Caſes *(w)* woven

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But in its *Aurelia* State it hath a quite different Body, with a *Club-Head* (in which the Head, *Thorax*, and Wings of the *Gnat* are incloſed), a ſlender *Alvus*, and a neat *finny Tail*, ſtanding at right Angles with the Body, quite contrary to what it was before; by which Means, inſtead of eaſy flapping ſideways, it ſwims by rapid briſk Jirks, the quite contrary Way; as is in ſome Meaſure repreſented in *Fig.* 13. But when it becomes a *Gnat*, no finny Tail, no Club-Head, but all is made in the moſt accurate Manner for Flight and Motion in the Air, as before it was for the Waters.

(s) See *Book* IV. *Chap.* 13. *Notes (n), (o).*

(t) Thus the Mouths and other Parts of the *Ichneumon-Waſps*, in *Book* IV. *Chap.* 13. *Note (c).* So the Feet of the *Gryllotalpa*, ibid. *Note (s).*

(u) See the laſt cited Places, *Note (o).*

(w) Of the textrine Art of the *Spider*, and its Parts ſerving to that Purpoſe, ſee the laſt cited Place, *Note (x).*

Beſides theſe, *Caterpillars*, and divers other Inſects, can emit Threads, or Webs, for their Uſe. In this their *Nympha State*, they ſecure themſelves from falling, and let themſelves down from the Boughs of Trees, and other high Places with one of theſe Threads. And in the Caſes they weave, they ſecure themſelves in their *Aurelia State.*

And

ven by others. And here that natural Glue *(x)* which their Bodies afford ſome of them to conſolidate their Work, and combine its Materials together, and which in others can be darted out at Pleaſure, and ſpun and woven by them into ſilken Balls *(y)* or Webs: I ſay, this ſo peculiar, ſo

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And not only the Offspring of the *Phalæna-Tribe*, but there are ſome of the *Ichneumon-Fly* Kind alſo, endowed with this textrine Art. Of theſe I have met with two Sorts; one that ſpun a Milk-white, long, round, ſilken Web, as big as the Top of one's Finger, not hollow within, as many are, but filled throughout with ſilk. Theſe are woven round Bents, Stalks of Ribwort, *&c.* in Meadows. The other is a Lump of many yellow, ſilken Caſes, ſticking confuſedly together on Poſts, under Coleworts, *&c.* Theſe webs contain in them, ſmall, whitiſh Maggots; which turn to a ſmall, black *Ichneumon-Fly*, with long, capillary *Antennæ*; Tan-coloured Legs; long Wings reaching beyond their Body, with a black Spot near the Middle; the *Alvus* like an Heart; and in ſome, a ſmall ſetaceous Tail. Some of theſe Flies were of a ſhining, beautiful green Colour. I could not perceive any Difference, at leaſt not ſpecifical, between the Flies coming from thoſe two Productions.

(x) I have often admired how *Waſps*, *Hornets*, *Ichneumon-Waſps*, and other Inſects that gather dry Materials for building their Neſts, have found a proper Matter to cement and glue their Combs, and line their Cells; which we find always ſufficiently context and firm. But in all Probability, this uſeful Material is in their own Bodies; as it is in the *Tinea Veſtivora*, the *Cadew-Worm*, and divers others. *Geodart* obſerves of his *Eruca*, *Num.* xx. 6. that fed upon *Sallow-Leaves*, that it made its Cell of the comminuted Leaves, glued together with its own Spittle: *Hæc pulveris aut arenæ inſtar comminuit, ac pituitoſo quodam ſui corporis ſucco ita maceravit, ut inde accommodatum ſubeundæ mutationi inſtanti locum ſibi exſtruxerit. Domuncula hæc à communi Salicum ligno nihil differre videbatur, niſi quòd longè eſſet durior, adeò ut cultro vix diſrumpi poſſet.*

(y) An ingenious Gentlewoman of my Acquaintance, Wiſe to a learned Phyſician, taking much Pleaſure to keep Silk-Worms, had once the Curioſity to draw out one of the oval Caſes, which the Silk Worm ſpins — into all the Silken Wire it was made up of, which, to the great Wonder as well of her Huſ-

band,

ſo ſerviceable a Material, together with the curious Structure of all Parts adminiſtering to this textrine Power, as mean a Buſineſs as it may ſeem, is ſuch as may juſtly be accounted among the noble Deſigns and Works of the infinite Creator and Conſervator of the World.

In the laſt Place, there is another prodigious Faculty, Art, Cunning, or what ſhall I call it? that others of thoſe little Animals have, to make even Nature itſelf ſerviceable to their Purpoſe; and that is, the making the Vegetation and Growth of Trees and Plants, the very means of the building of their little Neſts and Cells (z), ſuch as are the Galls

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band, as herſelf, — appeared to be, by Meaſure, a great deal above 300 *Yards, and yet weighed but two Grains and an half.* Boyle Subtil. of Effluv. Chap. ii.

(z) Since my penning this, I have met with the moſt ſagacious *Malpighi*'s Account of *Galls*, &c. and find his Deſcriptions to be exceedingly accurate and true, having traced myſelf many of the Productions he hath mentioned. But I find *Italy* and *Sicily* (his Book *de Gallis* being publiſhed long after he was made Profeſſor of *Meſſina*) more luxuriant in ſuch Productions than *England*, at leaſt than the Parts about *Upminſter* (where I live) are. For many, if not moſt of thoſe about us, are taken Notice of by him, and ſeveral others beſides that I never met with; although I have for many Years as critically obſerved all the Excreſcences, and other morbid Tumours of Vegetables, as is almoſt poſſible, and do believe that few of them have eſcaped me.

As to the method how thoſe *Galls* and *Balls* are produced, the moſt ſimple, and conſequently the moſt eaſy to be accounted for, is that in the Gems of Oak, which may be called *Squamous Oak-Cones*, *Capitula Squamata*, in *Malpighi*: Whoſe Deſcription not exactly anſwering our *Engliſh Cones* in divers Reſpects, I ſhall therefore paſs his by, and ſhew only what I have obſerved myſelf concerning them.

Theſe *Cones* are, in outward Appearance, perfectly like the Gems, only vaſtly bigger; and indeed they are no other than the Gems, increaſed in Bigneſs, which naturally ought to be puſhed out in Length; the Cauſe of which Obſtruction

Galls and Balls found on the Leaves and Branches of divers Vegetables, ſuch as the Oak, the Willow *(aa)*, the Briar, and ſome others.

Now

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tion of the Vegetation is this; Into the very Heart of the young tender Gem or Bud (which begins to be turgid in *June*, and to ſhoot towards the latter End of that Month, or Beginning of the next; into this, I ſay,) the Parent-Inſect thruſts one or more Eggs, and not perhaps without ſome venomous Ichor therewith. This Egg ſoon becomes a Maggot, which eats itſelf a little Cell in the very Heart or Pith of the Gem, which is the Rudiment of the Branch, together with its Leaves and Fruit, as ſhall be hereafter ſhewn. The Branch being thus wholly deſtroyed, or at leaſt its Vegetation being obſtructed, the Sap that was to nouriſh it, is diverted to the remaining Parts of the Bud, which are only the ſcaly Teguments; which by theſe Means grow large and flouriſhing, and become a Covering to the Inſect-Caſe, as before they were to the tender Branch and its Appendage.

The *Caſe* lying within this Cone, is at firſt but ſmall, as the Maggot included in it is; but by degrees, as the Maggot increaſeth, ſo it grows bigger, to about the Size of a large white Pea, long and round, reſembling the Shape of a ſmall Acorn.

The *Inſect* itſelf is (according to the modern Inſectologers) of the *Ichneumon-Fly* Kind; with four membranaceous *Wings*, reaching a little beyond the Body, articulated *Horns*, a large *Thorax*, bigger than the Belly; the *Belly* ſhort and conical, much like the Heart of Animals; the *Legs* partly whitiſh, partly black. The *Length* of the Body from Head to Tail, about $\frac{2}{10}$ of an Inch; its *Colour*, a very beautiful ſhining Green, in ſome tending to a dark Copper-Colour. Figures both of the Cones, Caſes, and Inſects, may be ſeen among *Malpighi*'s Cuts of Galls, *Tab.* 13. and *Tab.* 20. *Fig.* 72. which *Fig.* 72. exhibits well enough ſome others of the *Gall-Inſects*, but its *Thorax* is ſomewhat too ſhort for ours.

(aa) Not only the Willow, and ſome other Trees, but Plants alſo, as *Nettles*, *Ground-Ivy*, &c. have Caſes produced on their Leaves, by the Injection of the Eggs of an *Ichneumon-Fly*. I have obſerved thoſe Caſes always to grow in, or adjoining to ſome Rib of the Leaf, and their Production I conceive to be thus, *viz.* The Parent Inſect, with its ſtiff ſetaceous Tail, terebrates the Rib of the Leaf, when

tender,

Now this is ſo peculiar an Artifice, and ſo far out of the Reach of any mortal Underſtanding, Wit, or Power, that if we conſider the Matter, with ſome of its Circumſtances, we muſt needs perceive manifeſt Deſign, and that there is the Concurrence of ſome great and wiſe Being, that hath, from the Beginning, taken Care of, and provided for, the Animal's Good: For which Reaſon, as mean as the Inſtance may ſeem, I might be excuſed, if I ſhould enlarge upon its Particulars. But two or three Hints ſhall ſuffice.

In the firſt Place, it is certain that the Formation of thoſe *Caſes* and *Balls* quite exceeds the Cunning of the Animal itſelf; but it is the Act partly of the Vegetable, and partly of ſome Virulency (or what ſhall I call it?) in the Juice, or Egg, or both, repoſited on the Vegetable by the Parent Animal *(bb)*. And as this Virulency is various,

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tender, and makes Way for its Egg into the very Pith or Heart thereof, and probably lays in therewith, ſome proper Juice of its Body, to pervert the regular Vegetation of it. From this Wound ariſes a ſmall Excreſcence, which (when the Egg is hatched into a Maggot) grows bigger and bigger, as the Maggot increaſes, ſwelling on each Side the Leaf between the two Membranes, and extending itſelf into the parenchymous Part thereof, until it is grown as big as two Grains of Wheat. In this Caſe lies a ſmall, white, rough Maggot, which turns to an *Aurelia*, and afterwards to a very beautiful green, ſmall *Ichneumon-Fly*.

(bb) What I ſuſpected myſelf, I find confirmed by *Malpighi*, who, in his exact and true Deſcription of the Fly bred in the *Oaken Galls*, ſaith, *Non ſat fuit naturæ tam miro artificio Terebram ſeu Limam condidiſſe; ſed inflicto vulnere, vel excitato foramine infundendum exinde liquorem intra Terebram condidit: quare fractâ per tranſverſum muſcarum terebrâ frequentiſſimè, vivente animali, guttæ aliquot diaphani humoris effluunt.* And a little after, he confirms, by ocular Obſervation, what he imagined before, viz. *Semel prope Junii finem vidi Muſcam, qualem ſuperiùs delineavi, inſidentem quercinæ gemmæ, adhuc germinanti; hærebat etenim foliolo ſtabili ab apice*

various, according to the Difference of its Animal, ſo is the Form and Texture of the Caſes and Balls excited thereby, ſome being hard Shells *(cc)*, ſome tender Balls *(dd)*, ſome Scaly,

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apice hiantis gemmæ erumpenti; & convulſo in arcum corpore, terebram evaginabat, ipſumque tenſam immittebat; & tumefacto ventre circa terebræ radicem tumorem excitabat, quem interpolatis vicibus remittebat. In folio igitur, avulſâ Muſcâ, minima & diaphana reperi ejecta ova, ſimillima iis, quæ adhuc in tubis ſupererant. Non licuit iterum idem admirari ſpectaculum, &c.

Somewhat like this, which *Malpighi* ſaw, I had the good Fortune to ſee myſelf once, ſome Years ago: And that was, the beautiful, ſhining *Oak-Ball Ichneumon* ſtrike its *Terebra* into an Oak-Apple divers Times, no doubt to lay its Eggs therein. And hence I apprehend we ſee many *Vermicules* towards the Outſide of many of the Oak-Apples, which I gueſs were not what the Primitive Inſects laid up in the Gem, from which the Oak-Apple had its Riſe, but ſome other ſupervenient, additional Inſects, laid in after the Apple was grown, and whilſt it was tender and ſoft.

(cc) The *Aleppo-Galls*, wherewith we make Ink, may be reckoned of this Number, being hard, and no other than Caſes of Inſects which are bred in them; who when come to Maturity, gnaw their Way out of them; which is the Cauſe of thoſe little Holes obſervable in them. Of the Inſects bred in them, ſee *Philoſ. Tranſact.* N° 245. Of this Number alſo are thoſe little ſmooth Caſes, as big as large Pepper Corns, growing cloſe to the Ribs under Oaken-Leaves, globous, but flattiſh; at firſt touched with a bluſhing red, afterwards growing brown, hollow within, and an hard thin Shell without. In this lieth commonly a rough, white Maggot, which becomes a little long-winged, black *Ichneumon-Fly*, that eats a little Hole in the Side of the Gall, and ſo gets out.

(dd) For a Sample of the tender Balls, I ſhall chuſe the globous Ball, as round, and ſome as big as ſmall Muſket-Bullets, growing cloſe to the Ribs under Oaken-Leaves, of a greeniſh yellowiſh Colour, with a bluſh of red; their Skin ſmooth, with frequent Riſings therein. Inwardly they are very ſoft and ſpungy; and in the very Center is a Caſe with a white Maggot therein, which becomes an *Ichneumon-Fly*, not much unlike the laſt. As to this Gall, there is one Thing I have obſerved ſomewhat peculiar, and I may ſay providential,

ly *(ee)*, ſome Smooth *(ff)*, ſome Hairy *(gg)*, ſome Long,

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vidential, and that is, that the Fly lies all the Winter in theſe Balls in its Infantile-State, and comes not to its Maturity till the following Spring. In the Autumn, and Winter, theſe Balls fall down with their Leaves to the Ground, and the Inſect incloſed in them is there fenced againſt the Winter Froſts, partly by other Leaves falling pretty thick upon them, and eſpecially by the thick, parenchymous, ſpongy Walls, afforded by the *Galls* themſelves.

Another Sample ſhall be the large *Oak-Balls*, called *Oak-Apples*, growing in the Place of the Buds, whoſe Generation, Vegetation, and Figure, may be ſeen in *Malpig. de Gallis*, p. 24. and *Tab.* 10. *Fig.* 33. *&c.* Out of theſe Galls, he ſaith, various Species of Flies come, but he names only two, and they are the only two I ever ſaw come out of them: *Frequenter* (ſaith he) *ſubnigræ ſunt muſcæ brevi munitæ terebrâ. Inter has aliquæ obſervantur aureæ, levi viridis tincturâ ſuffuſæ, oblongâ pollentes terebrâ.* Thoſe two differently-coloured Flies, I take to be no other than Male and Female of the ſame Species. I have not obſerved Tails (which are their *Terebræ*) in all, as *Malpighi* ſeems to intimate: Perhaps they were hid in their *Thecæ*, and I could not diſcover them: But I rather think there were none, and that thoſe were the Males: But in others, I have obſerved long, recurvous Tails, longer than their whole Bodies. And theſe I take to be the Females. And in the *Oak-Apples* themſelves, I have ſeen the *Aureliæ*, ſome with, ſome without Tails. And I muſt confeſs, it was not without Admiration, as well as Pleaſure, that I have ſeen with what exact Neatneſs and Artifice, the Tail hath been wrapt about the *Aurelia*, whereby it is ſecured from either annoying the Inſect, or being hurt itſelf.

(ee) See before, *Note (z)*.

(ff) As in the preceding Note.

(gg) Of the rough or hairy Excreſcences, thoſe on the *Brier*, or *Dog-Roſe*, are a good Inſtance. Theſe *Spongiolæ Villoſæ*, as Mr. *Ray*, *Gallæ Rumoſæ*, as Dr. *Malpighi* calls them, are thus accounted for by the latter; *Ex copioſis relictis ovis ita turbatur affluens* [Rubi] *ſuccus, ut ſtrumoſa fiant complura tubercula ſimul confuſè congeſta, quæ utriculorum ſeriebus, & fibrarum implicatione contexta, ramoſas propagines germinant, ita ut minima quaſi ſylva appareat. Quælibet propago ramos, hinc inde villoſos edit. Hinc inde pili pariter erumpunt, &c.*

Theſe Balls are a ſafe Repoſitory to the Inſect all the Winter in its Vermicular-State. For the Eggs laid up, and hatched the Summer before, do not come to mature Inſects until the

Long, ſome Round, ſome Conical, *&c.* *(bb)*. And in the laſt Place, let us add, That thoſe Species of Inſects are all endowed with peculiar and exactly made Parts for this Service to bore and pierce the Vegetable, and to reach and inject their Eggs and Juice into the tender Parts thereof.

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the Spring following, as Mr. *Ray* rightly obſerves in *Cat. Cantab.*

As to the *Inſects* themſelves, they are manifeſtly *Ichneumon-Flies*, having four Wings, their *Alvus*, thick and large towards the Tail; and tapering up till it is ſmall and ſlender at its ſetting on to the *Thorax*. But the *Alvi* or Bellies, are not alike in all, though coloured alike. In ſome they are as is now deſcribed, and longer, without *Terebræ*, or Tails; in ſome ſhorter, with Tails; and in ſome yet ſhorter, and thick, like the Belly of the *Ant*, or the Heart of Animals, as in thoſe before, *Note (z)*. But for a farther Deſcription of them, I ſhall refer to Mr. *Ray*, *Cat. Plant. circa Cantab.* under *Roſa ſylveſt.*

(bb) It being an Inſtance ſomewhat out of the Way, I ſhall pitch upon it for an Example here, *viz* The *gouty Swellings* in the Body, and the Branches of the *Blackberry-Buſh*; of which *Malpighi* hath given us two good Cuts in *Tab.* 17. *Fig.* 62. The Cauſe of theſe is manifeſtly from the Eggs of Inſects laid in (whilſt the Shoot is young and tender) as far as the Pith, and in ſome Places not ſo deep: Which, for the Reaſons before-mentioned, makes the young Shoots tumefy, and grow knotty and gouty.

The Inſect that comes from hence is of the former Tribe, a ſmall, ſhining black *Ichneumon-Fly*, about a tenth of an Inch long, with jointed, red, capillary-Horns, four long Wings, reaching beyond the Body, a large *Thorax*, red Legs, and a ſhort heart-like Belly. They hop like Fleas. The Males are leſs than the Females; are very venerous, endeavouring a *Coït* in the very Box in which they are hatched; getting up on the Females, and tickling and thumping them with their Breeches and Horns, to excite them to Venery.

The Concluſion.

AND now, theſe Things being ſeriouſly conſidered, what leſs can be concluded, than that there is manifeſt Deſign and Forecaſt in this Caſe, and that there muſt needs be ſome wiſe Artiſt, ſome careful, prudent Conſervator, that from the very Beginning of the Exiſtence of this Species of Animals, hath, with great Dexterity and Forecaſt, provided for its Preſervation and Good? For what elſe could contrive and make ſuch a Set of curious Parts, exactly fitted up for that ſpecial Purpoſe: And withal implant in the Body ſuch peculiar Impregnations, as ſhould have ſuch a ſtrange uncouth Power on a quite different Rank of Creatures? And laſtly, what ſhould make the Inſect aware of this its ſtrange Faculty and Power, and teach it ſo cunningly and dexterouſly to employ it for its own Service and Good?

BOOK IX.

Of REPTILES, and the Inhabitants of the Waters.

CHAP. I.

Of Reptiles.

HAVING diſpatched the Inſect-Tribe, there is but one *Genus* of the Land-Animals remaining to be ſurveyed, and that is, that of *Reptiles* (a). Which I ſhall diſpatch in a little Compaſs, by reaſon I have ſomewhat amply treated of others, and many of the Things may be applied here. But there are

ſome

(a) Notwithſtanding I have before, in *Book* IV. *Chap.* 12. *Note (p)*, taken Notice of the *Earth-worm*; yet it being a good Example of the Creator's wiſe and curious Workmanſhip, in even this meaneſt Branch of the Creation, I ſhall ſuperadd a few farther Remarks from Drs. *Willis* and *Tyſon*. Saith *Willis*, *Lumbricus terreſtris, licèt vile & contemptibile habetur, Organa vitalia, necnon & alia viſcera, & membra divino artificio admirabiliter ſabreſacta ſortitur: totius corporis compages muſcu-*

lorum

ſome Things in which this Tribe is ſomewhat ſingular, which I ſhall therefore take Notice of briefly in this Place. One is their Motion, which I have in another Place *(b)* taken Notice of to be not leſs curious, than it is different from that of other Animals, whether we conſider the Manner of it, as vermicular, or ſinuous *(c)*, or like that of the

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lorum annularium catena eſt, quorum fibræ orbiculares contractæ quemque annulum, prius amplum, & dilatum, anguſtiorem & longiorem reddunt. [This Muſcle in Earth-Worms I find is ſpiral, as in a good Meaſure is their Motion likewiſe; *ſo that by this Means they can, (like the Worm of an Augre,) the better bore their Paſſage into the Earth. Their Reptile Motion alſo, may be explained by a Wire wound on a Cylinder, which when ſlipped off, and one End extended and held faſt, will bring the other nearer it. So the Earth Worm, having ſhot out, or extended its Body, (which is with a Wreathing,) it takes hold by thoſe ſmall Feet it hath, and ſo contracts the hinder Part of its Body.* Thus the curious and learned Dr. *Tyſon,* Philoſ. Tranſ. N°. 147] *Nam proinde cùm portio corporis ſuperior elongata, & exporrecta ad ſpatium alterius extenditur, ibidemque plano affigitur, ad ipſum quaſi ad centrum portio corporis inferior relaxata, & abbreviata facilè pertrahitur. Pedunculi ſerie quadruplici, per totam longitudinem Lumbrici diſponuntur; his quaſi totidem uncis, partem modò hanc, modò iſtam, plano affigit, dum alteram exporrigit, aut poſt ſe ducit. Supra oris hiatum, Proboſcide, quâ terram perforat & elevat, donatur.* And then he goes on with the other Parts that fall under View, the *Brain,* the *Gullet,* the *Heart,* the *Spermatick Veſſels,* the *Stomach* and *Inteſtines,* the *Foramina* on the Top of the Back, adjoining to each Ring, ſupplying the Place of Lungs, and other Parts. *Willis de Anim. Brut.* P. i. cap. 3.

(b) In *Book* IV. *Chap.* 8.

(c) There is a great deal of Geometrical Neatneſs and Nicety, in the ſinuous Motion of Snakes, and other Serpents, For the aſſiſting in which Action, the annular Scales under their Body are very remarkable, lying croſs the Belly, contrary to what thoſe in the Back, and the reſt of the Body, do; alſo as the Edges of the foremoſt Scales lie over the Edges of their following Scales, from Head to Tail; ſo thoſe Edges run out a little beyond, or over their following Scales; ſo as that when each Scale is drawn back, or ſet a little upright, by its Muſcle, the outer Edge thereof, (or Foot it may be called,)

the Snail *(d)*, or the Caterpillar *(e)*, or the Multipedous *(f)*, or any other Way; or the Parts miniſtring

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called,) is raiſed alſo a little from the Body, to lay hold on the Earth, and ſo promote and facilitate the Serpent's Motion. This is what may be eaſily ſeen in the Slough, or Belly of the Serpent-Kind. But there is another admirable Piece of Mechaniſm, that my Antipathy to thoſe Animals hath prevented my prying into; and that is, that every Scale hath a diſtinct Muſcle, one End of which is tacked to the Middle of its Scale; the other, to the upper Edge of its following Scale. This Dr. *Tyſon* found in the *Rattle-Snake*, and I doubt not is in the whole Tribe.

(d) The wiſe Author of Nature, having denied Feet and Claws to enable Snails to creep and climb, hath made them Amends in a way more commodious for their State of Life, by the broad Skin along each Side of the Belly, and the undulating Motion obſervable there. By this latter it is they creep; by the former, aſſiſted with the glutinous Slime emitted from the Snail's Body, they adhere firmly and ſecurely to all Kinds of Superficies, partly by the Tenacity of their Slime, and partly by the Preſſure of the Atmoſphere. Concerning this Part, (which he calls the *Snail's-Feet,*) and their Undulation, ſee Dr. *Liſter*'s *Exercit. Anat.* 1. ſect. 1. & 37.

(e) The motive Parts, and Motion of Caterpillars, are uſeful, not only to their Progreſſion and Conveyance from Place to Place; but alſo to their more certain, eaſy, and commodious gathering of Food: For having Feet before and behind, they are not only enabled to go by a kind of Steps made by their fore and hind-Parts; but alſo to climb up Vegetables, and to reach from their Boughs and Stalks for Food at a Diſtance; for which Services, their Feet are very nicely made both before and behind. Behind, they have broad Palms for ſticking to, and theſe beſet almoſt round with ſmall ſharp Nails, to hold and graſp what they are upon: Before, their Feet are ſharp and hooked, to draw Leaves, *&c.* to them, and to hold the fore-part of the Body, whilſt the hinder parts are brought up thereto. But nothing is more remarkable in theſe Reptiles, than that theſe Parts and Motion are only temporary, and incomparably adapted only to their preſent *Nympha-State*; whereas in their *Aurelia State*, they have neither Feet nor Motion, only a little in their Hinder-Parts: And in their *Mature-State*, they have the Parts and Motion of a flying Inſect, made for Flight.

(f) It is a wonderful pretty Mechaniſm, obſervable

niſtring to it, particularly the Spine *(g)*, and the Muſcles co-operating with the Spine, in ſuch as have Bone, and the annular, and other Muſcles, in ſuch as have none, all incomparably made for thoſe curious, and I may ſay, geometrical Windings and Turnings, Undulations, and all the various Motions to be met with in the Reptile Kind.

Another Thing that will deſerve our Notice, is, the Poiſon *(h)* that many of this Tribe are ſtocked with.

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going of *Multipedes*, as the *Juli*, *Scolopendræ*, &c. that on each Side the Body, every Leg hath its Motion, one very regularly following the other from one End of the Body to the other, in a Way not eaſy to be deſcribed in Words; ſo that their Legs in going, make a kind of Undulation, and give the Body a ſwifter Progreſſion than one would imagine it ſhould have, where ſo many Feet are to take ſo many ſhort Steps.

(g) Vertebrarum Apophyſes breviores ſunt, præcipue juxta caput, cujus propterea flexus in averſum, & latera, facilis Viperis eſt: ſecus Leonibus, &c.—Incumbit his Oſſibus ingens Muſculorum minutorum præſidium, tum ſpinas tendinum exilium magno apparatu diducentium, tum vertebras potiſſimum in diverſa flectentium, atque erigentium. Adeoque illam corporis miram agilitatem, non tantùm (ut Ariſtot.) ὅτι εὐκαμπεῖς ϗ χονδρώδεις οἱ σπόνδυλοι, *quoniam faciles ad flexum, & cartilagineas produxit vertebras, ſed quia etiam multiplicia motûs localis inſtrumenta muſculos fabrefecit provida rerum Parens Natura, conſecuta fuit.* Blaſ. Anat. Anim. P. 1. cap. 39. de Viperâ è Veſlingio.

That which is moſt remarkable in the Vertebræ [of the *Rattle-Snake*, beſides the other curious Articulations,] *is, that the round Ball in the lower Part of the upper* Vertebra, *enters a Socket of the upper Part of the lower* Vertebra, *like as the Head of the* Os Femoris *doth the* Acetabulum *of the* Os Iſchii; *by which Contrivance, as alſo the Articulation with one another, they have that free Motion of winding their Bodies any way.* Dr. *Tyſon*'s Anat. of the *Rattle-Snake* in *Philoſ. Tranſ.* N° 144. What is here obſerved of the *Vertebræ* of this *Snake*, is common to this whole *Genus* of Reptiles.

(h) My ingenious and learned Friend, Dr. *Mead*, examined with his Microſcope, the Texture of a *Viper's Poiſon*, and found

with. Which I the rather mention becauſe ſome make it an Objection againſt the Divine Superintendence and Providence, as being a Thing ſo far from uſeful, (they think,) that it is rather miſchievous and deſtructive of God's Creatures. But the Anſwer is eaſy, *viz.* That as to Man, thoſe Creatures are not without their great Uſes, particularly in the Cure of (i) ſome of the moſt ſtubborn

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found therein at firſt only *a Parcel of ſmall Salts nimbly floating in the Liquor; but in a ſhort Time the Appearance was changed, and theſe ſaline Particles were ſhot out into Cryſtals, of an incredible Tenuity and Sharpneſs, with ſomething like Knots here and there, from which they ſeemed to proceed; ſo that the whole Texture did in a Manner repreſent a Spider's Web, though infinitely finer.* Mead of Poiſons, p. 9.

As to the Nature and Operation of this *Poiſon*, ſee the ſame Ingenious Author's Hypotheſis, in his following Pages.

This *Poiſon* of the *Viper* lieth in a Bag in the Gums, at the Upper-End of the Teeth. It is ſeparated from the Blood by a *conglomerated Gland*, lying in the anterior lateral Part of the *Os Sincipitis*, juſt behind the Orbit of the Eye: From which Gland lieth a Duct, that conveys the Poiſon to the Bags at the Teeth.

The Teeth are tubulated, for the Conveyance, or Emiſſion of the Poiſon into the Wound the Teeth make; but their Hollowneſs doth not reach to the *Apex*, or Top of the Tooth, (that being ſolid and ſharp, the better to pierce;) but it ends in a long Slit below the Point, out of which the Poiſon is emitted. Theſe Perforations of the Teeth, *Galen* ſaith, the Mountebanks uſed to ſtop with ſome kind of Paſte, before they ſuffered the Vipers to bite them before their Spectators. Cuts of theſe Parts, *&c.* may be ſeen in the laſt cited Book of Dr. *Mead.* Alſo Dr. *Tyſon's Anat. of the Rattle Snake*, in *Phil. Tranſ.* N° 144.

(i) That Vipers have their great Uſes in Phyſick, is manifeſt from their bearing a great Share in ſome of our beſt Antidotes, ſuch as *Theriaca Andromachi*, and others; alſo in the Cure of the *Elephantiaſis*, and other the like ſtubborn Maladies, for which I ſhall refer to the medical Writers. But there is ſo ſingular a Caſe in the curious Collection of Dr. *Ol. Worm.* related from *Kircher*, that I ſhall entertain the Reader with it. Near the Village of *Saſſa*, about eight Miles from the City *Bracciano* in *Italy*, ſaith he, *Specus ſeu caverna (vulgò* born Diſeaſes; however, if they were not, there would be no Injuſtice for God to make a Set of ſuch noxious Creatures, as Rods and Scourges, to execute the Divine Chaſtiſements upon ungrateful and ſinful Men. And I am apt to think that the Nations which know not God, are the moſt annoyed with thoſe noxious Reptiles and other pernicious Creatures. As to the Animals themſelves, their Poiſon is, no doubt, of ſome great and eſpecial Uſe to themſelves, ſerving to the more eaſy Conqueſt, and ſure Capture of their Prey, which might other-

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La Grotta del Serpi) duorum hominum capax, fiſtuloſis quibuſdam foraminibus in formam cribri perforata cernitur, ex quibus ingens quædam, principio veris, diverſicolorum Serpentum, nullâ tamen, ut dicitur, ſingulari veneni qualitate imbutorum progenies quotannis pullulare ſolet. In hâc ſpeluncâ Elephantiacos, Leproſos, Paralyticos, Arthriticos, Podagricos, &c. nudos exponere ſolent, qui mox halituum ſubterraneorum calore in ſudorem reſoluti, Serpentum propullulantium, totum corpus infirmi implicantium, ſuctu linctuque ita omni vitioſo virulentoque humore privare dicuntur, ut repetito hoc per aliquod tempus medicamento, tandem perfectæ ſanitati reſtituantur. This Cave *Kircher* viſited himſelf, found it warm, and every way agreeable to the Deſcription he had of it; he ſaw their Holes, heard a murmuring hiſſing Noiſe in them; but although he miſſed ſeeing the Serpents, (it being not the Seaſon of their creeping out) yet he ſaw great Numbers of their *Exuviæ*, or *Sloughs*, and an Elm growing hard by, laden with them.

The Diſcovery of this Cave, was by the Cure of a *Leper* going from *Rome* to ſome Baths near this Place; who loſing his Way, and being benighted, happened upon this Cave; and finding it very warm, pulled off his Clothes, and being weary and ſleepy, had the good Fortune not to feel the Serpents about him till they had wrought his Cure. *Vide Muſeum Worm.* lib. iii. cap. 9.

The before-commended Dr. *Mead* thinks our Phyſicians deal too cautiouſly and ſparingly, in their preſcribing only ſmall Quantities of the Viper's Fleſh, &c. in the *Elephantiaſis*, and ſtubborn *Leproſies:* But he recommended rather the Gelly or Broth of Vipers; or, as the antient Manner was, to boil Vipers, and eat them like Fiſh; or at leaſt to drink Wine, in which they have been long infuſed. *Vide Mead, ubi ſupra,* p. 34.

wiſe be too reſty and ſtrong, and if once eſcaped would hardly be again recovered by reaſon of their ſwifter Motion, and the Help of their Legs; beſides all which, this their Poiſon may probably be of very great Uſe to the Digeſtion of their Food.

And as to the innocuous Part of the Reptile-Kind, they as well deſerve our Notice for their Harmleſneſs, as the others did for their Poiſon. For as thoſe are endowed with Poiſon, becauſe they are predaceous; ſo theſe need it not, becauſe their Food is near at hand, and may be obtained without Strife and Conteſt, the next Earth *(k)* affording Food to ſuch as can terebrate, and make Way into it by their Vermicular Faculty; and the next Vegetable being Food to others that can climb and reach *(l)*, or but crawl to it.

(k) That *Earth Worms* live upon Earth, is manifeſt from the little curled Heaps of their Dung ejected out of their Holes. But in *Philoſ. Tranſ.* N° 291. I have ſaid, it is in all Probability Earth made of rotted Roots and Plants, and ſuch like nutritive Things, not pure Earth. And there is farther Reaſon for it, becauſe Worms will drag the Leaves of Trees into their Holes.

(l) *Snails* might be in danger of wanting Food, if they were to live only upon ſuch tender Plants as are near the Ground, within their Reach only; to impower them therefore to extend their Purſuits farther, they are enabled by the Means mentioned in *Note (d)*, to ſtick unto, and creep up Walls and Vegetables at their Pleaſure.

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CHAP. II.

Of the Inhabitants of the Waters.

I Have now gone through that Part of the Animal World, which I propoſed to ſurvey, the Animals inhabiting the Land.

As to the other Part of the Terraqueous Globe, the Waters, and the Inhabitants thereof, not having Time to finiſh what I have begun on that large Subject, I ſhall be forced to quit it for the preſent, although we have there as ample and glorious a Scene of the Infinite Creator's Power and Art, as hath been already ſet forth on the dry Land. For the Waters themſelves are an admirable Work of God *(a)*, and of infinite Uſe *(b)* to that

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(a) Beſides their abſolute Neceſſity, and great Uſe to the World, there are ſeveral Topics, from whence the Waters may be demonſtrated to be God's Work; as, the creating ſo vaſt a Part of our Globe; the placing it commodiouſly therein, and giving it Bounds; the Methods of keeping it ſweet and clean, by its Saltneſs, by the Tides, and Agitations by the Winds; the making the Waters uſeful to the Vegetation of Plants, and for Food to Animals, by the noble Methods of ſweetening them; and many other Things beſides, which are inſiſted on in that Part of my Survey.

(b) Pliny having named divers *Mirabilia Aquarum*, to ſhew their Power; then proceeds to their Uſes, viz. *Eædem cadentes omnium terrâ naſcentium cauſa ſiunt, prorſus mirabili naturâ, ſiquis velit reputare, ut fruges gignantur, arbores fruticeſque vivant, in cælum migrare aquas, animamque etiam herbis vitalem inde deferre: juſtâ confeſſione, omnes terræ quoque vires aquarum eſſe beneficii. Quapropter ante omnia ipſarum potentiæ exempla ponemus: Cunctas enim quis mortalium enumerare queat?* And then he goes on with an Enumeration of ſome Waters famed for being Medicinal, or ſome other unuſual Quality. *Plin.* lib. xxxi. cap. 1, & 2.

that Part of the Globe already ſurveyed; and the prodigious Variety *(c)*, and Multitudes of curious and wonderful Things obſervable in its Inhabitants of all Sorts, are an inexhauſtible Scene of the Creator's Wiſdom and Power. The vaſt Bulk of ſome *(d)*, and prodigious Minuteneſs of others *(e)*, together with the incomparable Contrivance and Structure of the Bodies *(f)* of all; the Proviſions and Supplies of Food afforded to ſuch an innumerable Company of Eaters, and that in an Element, unlikely, one would think, to afford any great Store of Supplies *(g)*; the Buſineſs of Reſpiration per-

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(c) Pliny reckons 176 Kinds in the Waters, whoſe Names may be met with in his lib. xxxii. cap. 11. but he is ſhort in his Account.

(d) Pliny, lib. ix. cap. 3. ſaith, That in the *Indian* Sea there are *Balenæ quaternûm jugerum (i. e.* 960 Feet*) Priſtes* 200 *cubitorum (i. e.* 300 Feet.*)* And lib. xxxii. cap. 1. he mentions *Whales* 600 Feet long, and 360 broad, that came into a River of *Arabia*. If the Reader hath a Mind, he may ſee his Reaſon why the largeſt Animals are bred in the Sea, lib. ix. cap. 2.

(e) As the largeſt, ſo the moſt minute Animals are bred in the Waters, as thoſe in Pepper-water; and ſuch as make the green Scum on the Waters, or make them ſeem as if green, and many others. See *Book* IV. *Chap.* 11. *Note (n), (o)*.

(f) It might be here ſhewn, that the Bodies of all the ſeveral Inhabitants of the Waters, are the beſt contrived and ſuited to that Place and Buſineſs in the Waters, which is proper for them; that particularly, their Bodies are cloathed and guarded, in the beſt Manner, with Scales, or Shells, *&c.* ſuitable to the Place they are to reſide in, the Dangers they may there be expoſed unto, and the Motion and Buſineſs they are there to perform: That the Center of Gravity (of great Conſideration in that fluid Element,) is always placed in the fitteſt Part of the Body: That the Shape of their Bodies, (eſpecially the more ſwift,) is the moſt commodious for making Way through the Waters, and moſt agreeable to geometrical Rules: and many other Matters beſides, would deſerve a Place here, were they not too long for Notes, and that I ſhall anticipate what ſhall be more proper for another Place, and more accurately treated of there.

(g) See before, *Book* IV. *Chap.* 11.

formed in a Way ſo different from, but equivalent to what is in Land-Animals (*h*); the Adjuſtment of the Organs of Viſion (*i*) to that Element in which the Animal liveth; the Poiſe (*k*), the Support (*l*), the Motion of the Body (*m*), forwards with

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(*h*) *Galen* was aware of the Reſpiration of Fiſhes by their *Branchiæ*. For having ſaid, that Fiſhes have no Occaſion of a Voice, neither reſpire through the Mouth as Land Animals do, he ſaith, *Sed earum, quas Branchias nuncupamus, conſtructio, ipſis vice Pulmonis eſt. Cum enim crebris ac tenuibus foraminibus ſint Branchiæ hæ interceptæ, aëri quidem & vapori perviis, ſubtilioribus tamen quàm pro mole aquæ; hanc quidem extra repellunt, illa autem promptè intromittunt.* Galen de Uſ. Part. lib. vi. cap. 9. So alſo *Pliny* held, That Fiſhes reſpired by their Gills; but he ſaith *Ariſtotle* was of a different Opinion. *Plin.* lib. ix. cap. 7. And ſo *Ariſtotle* ſeems to be in his *Hiſtory of Animals*, lib. viii. cap. 2. and in other Places. And I may add our famous Dr. *Needham*. So his *De Form. Fœtu*, cap. 6. and *Anſwer to* Severinus.

(*i*) A protuberant Eye would have been inconvenient for Fiſhes, by hindering their Motion in ſo denſe a Medium as Water is; or elſe their bruſhing through ſo thick a Medium would have been apt to wear, and prejudice their Eyes; therefore their *Cornea* is flat. To make Amends for which, as alſo for the Refraction of Water, different from that of the Air, the wiſe Contriver of the Eye, hath made the *Cryſtalline* ſpherical in Fiſhes, which in Animals, living in the Air, is *lenticular*, and more flat.

(*k*) As I have ſhewed before, that the Bodies of Birds are nicely poiſed to ſwim in the Air, ſo are thoſe of Fiſhes for the Water, every Part of the Body being duly balanced, and the Center of Gravity, as I ſaid in *Note (f)*, accurately fixed. And, to prevent Vacillation, ſome of the Fins ſerve, particularly thoſe of the Belly; as *Borelli* proved, by cutting off the Belly-fins, which cauſed the Fiſh to reel to the right and left Hand, and rendered it unable to ſtand ſteadily in an upright Poſture.

(*l*) To enable the Fiſh to abide at the Top, or Bottom, or any other Part of the Waters, the Air-Bladder is given to moſt Fiſhes, which, as it is more full or empty, makes the Body more or leſs buoyant.

(*m*) The *Tail* is the grand Inſtrument of the Motion of the Body; not the Fins, as ſome imagine. For which Reaſon, Fiſhes are more muſculous and ſtrong in that Part, than in all the with great Swiftneſs, and upwards and downwards with great Readineſs and Agility, and all without Feet and Hands, and ten thouſand Things beſides; all theſe Things, I ſay, do lay before us ſo various, ſo glorious, and withal ſo inexhauſtible a Scene of the Divine Power, Wiſdom, and Goodneſs, that it would be in vain to engage myſelf in ſo large a Province, without allotting as much Time and Pains to it, as the preceding Survey hath coſt me. Paſſing by therefore that Part of our Globe, I ſhall only ſay ſomewhat very briefly concerning the *inſenſitive* Creatures, particularly thoſe of the *Vegetable Kingdom*, and ſo conclude this Survey.

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the reſt of their Body, according as it is in the motive Parts of all Animals, in the pectoral Muſcles of Birds, the Thighs of Man, &c.

If the Reader hath a Mind to ſee the admirable Method, how Fiſhes row themſelves by their Tail, and other Curioſities relating to their Swimming; I ſhall refer him to *Borelli de Mot. Animal.* part i. cap. 23. particularly to prop. 213.

BOOK X.

Of VEGETABLES.

THE Vegetable Kingdom, although an inferior Branch of the Creation, exhibits to us ſuch an ample Scene of the Creator's Contrivance, Curioſity, and Art, that I much rather chuſe to ſhew what might be ſaid, than engage too far in Particulars. I might inſiſt upon the great Variety there is, both of Trees and Plants provided for all Ages, and for every Uſe and Occaſion of the World (a); ſome for Building, for Tools and Utenſils of every kind; ſome hard, ſome ſoft; ſome tough and ſtrong, ſome brittle; ſome long and tall, ſome ſhort and low; ſome thick and large, ſome ſmall and ſlender; ſome for Phyſick (b), ſome for Food, ſome for Pleaſure; yea, the moſt abject (c) Shrubs, and the very Buſhes and Brambles themſelves, the Huſbandmen can teſtify the Uſe of.

(a) The fifth Book of *Theophraſtus's Hiſtory of Plants* may be here conſulted; where he gives ample Inſtances of the various Conſtitutions and Uſes of Trees, in various Works, *&c.* See alſo before *Book* IV. *Chap.* 13. *Note (a).*

(b) *Inviſis quoque herbis inſeruit* [Natura] *remedia: quippe cùm medicinas dederit etiam aculeatis — in quibus ipſis providentiam Naturæ ſatis admirari amplectique non eſt — Inde excogitavit aliquas aſpectu hiſpidas, tactu truces, ut tantùm non vocem ipſius fingentis illas, rationemque reddentis exaudire videamur, ne ſe depaſcat avida Quadrupes, ne procaces manus rapiant, ne neglecta veſtigia obterant, ne inſidens Ales infringat: his muniendo Aculeis, teliſque armando, remediis ut tuta ac ſalva ſint. Ita hoc quoque quod in iis odimus, hominum cauſâ excogitatum.* Plin. Nat. Hiſt. lib. xxii. cap. 6.

I might alſo Survey here the curious Anatomy and Structure of their Bodies (d), and ſhew the admi-

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Are ſome of the Species of Nature noxious? They are alſo uſeful. —Doth a Nettle ſting? It is to ſecure ſo good a Medicine from the Rapes of Children and Cattle. Doth the Bramble cumber a Garden? It makes the better Hedge; where if it chanceth to prick the Owner, it will tear a Thief. Grew's Coſmolog. lib. iii. cap. 2. ſect. 47.

(c) That the moſt abject Vegetables, *&c.* have their Uſe, and are beneficial to the World, may in ſome Meaſure appear from the Uſe the Northern People put rotten Wood, *&c.* unto. *Satis ingenioſum modum habent populi ſeptentrionales in nemoribus nocturno tempore pertranſeuntes, imo & diurno, quando in remotioribus Aquilonis partibus ante, & poſt Solſtitium hyemale continuæ noctes habentur. Quique his remediis indigent, Cortices quercinos inquirunt putres, eaſque collocant certo interſtitio itineris inſtitui, ut eorum ſplendore, quò voluerint, perficiant iter. Nec ſolùm hoc præſtat Cortex, ſed & Truncus putrefactus, ac fungus ipſe Agaricus appellatus, &c.* Ol. Mag. Hiſt. lib. ii. cap. 16.

To this we may add *Thiſtles* in making Glaſs, whoſe Aſhes, Dr. *Merret* ſaith, are the beſt, *viz.* the Aſhes of the *Common-way Thiſtle,* though all *Thiſtles* ſerve to this Purpoſe. Next to *Thiſtles* are *Hop-ſtrings,* cut after the Flowers are gathered. Plants that are Thorny and Prickly, ſeem to afford the beſt and moſt Salt. *Merret's Obſervations on Anton. Ner.* p. 265.

Quid mejora ſequar? Salices, humileſque Geniſtæ,
Aut illæ pecori frondem, aut paſtoribus umbram
Sufficiunt, Sepemque ſatis, & pabula melli.

Virg. Georg. lib. ii. ver. 434.

(d) Dr. *Beal* (who was very curious, and tried many Experiments upon Vegetables) gives ſome good Reaſons to imagine, that there is a direct Communication between the Parts of the Tree and the Fruit, ſo that the ſame Fibres which conſtitute the Root, Trunk, and Boughs, are extended into the very Fruit. And in old *Horn-beans,* I have ob-admirable Proviſion made for the Conveyance of the lymphatick and eſſential Juices, for communicating the Air, as neceſſary to Vegetable, as Animal Life (*e*): I might alſo ſpeak of even the very Covering they are provided with, becauſe it is a curious Work in Reality, although leſs ſo in Appearance: And much more therefore might I ſurvey

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ſerved ſomething very like this; in many of which, there are divers great and ſmall Ribs (almoſt like Ivy, only united to the Body) running from the Root up along the Outſide of the Body, and terminating in one ſingle, or a few Boughs; Which Bough or Boughs ſpread again into Branches, Leaves, and Fruit. See what Dr. *Beal* hath in *Lowth. Abridg.* vol. ii. p. 710.

But as to the particular Canals, and other Parts relating to the Anatomy of Vegetables, it is too long a Subject for this Place, and therefore I ſhall refer to Seign. *Malpighi*'s and Dr. *Grew*'s Labours in this Kind.

(*e*) *Tanta eſt Reſpirationis neceſſitas, & uſus, ut Natura in ſingulis viventium ordinibus varia, ſed analoga, paraverit inſtrumenta, quæ Pulmones vocamus* [and ſo he goes on with obſerving the *Apparatus* made in the various *Genera* of Animals, and then ſaith,] *In Plantis verò, quæ infimum animalium attingunt ordinem, tantam Trachearum copiam & productionem extare par eſt, ut his minimæ Vegetantium partes præter corticem irrigentur.—Plantæ igitur (ut conjectari fas eſt) cùm ſint viventia, viſceribus infixa terræ, ab hac, ſeu potius ab aquâ & aëre, commixtis & percolatis à terrâ, Reſpirationis ſuæ materiam recipiunt, ipſarumque Tracheæ ab halitu terræ, extremas radices ſubingreſſo, replentur.* Malpig. Op. Anat. Plant. p. 15.

Theſe *Tracheæ*, or *Air-Veſſels*, are viſible, and appear very pretty in the Leaf of *Scabious*, or the Vine, by pulling aſunder ſome of its principal Ribs, or great Fibres; between which, may be ſeen the Spiral *Air-Veſſels* (like Threads of Cobweb) a little uncoiled: A Figure whereof, Dr. *Grew* hath given us in his *Anat. Plant. Tab.* 51, 52.

As to the curious Coiling, and other Things relating to the Structure of thoſe *Air-Veſſels*, I refer to *Malpig.* p. 14. and Dr. *Grew*, ib. lib. iii. cap. 3. ſect. 16, *&c.* and lib. iv. cap. 4. ſect. 19. of Mr. *Ray*, from them ſuccinctly. *Hiſt. Plant.* lib. i. cap. 4.

the neat Variety and Texture of their Leaves *(f)*, the admirable Finery, Gaiety, and Fragrancy of their Flowers *(g)*. I might alſo inquire into the wonder-

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(f) Concerning the *Leaves*, I ſhall Note only two or three Things: 1. As to the *Fibres of the Leaf*, they ſtand not in the *Stalk*, in an even Line, but always in an Angular, or Circular Poſture, and their vaſcular Fibres or Threads are 3, 5, or 7. The Reaſon of their Poſition thus, is for the more erect Growth and greater Strength of the Leaf, as alſo for the Security of its Sap. Of all which ſee Dr. *Grew*, lib. i. cap. 4. ſect. 8, *&c.* and lib. iv. part 1. cap. 3. alſo *Tab.* 4. *Fig.* 2, to 11. Another Obſervable in the Fibres of the Leaf, is their orderly Poſition, ſo as to take in an eighth Part of a Circle, as in *Mallows*; in ſome a tenth, but in moſt a twelfth, as in *Holy-Oak*; or a ſixth, as in *Syringa*. Id. ib. *Tab.* 46, 47.

2. The Art in *Folding up the Leaves* before their Eruption out of their Gems, *&c.* is incomparable, both for its Elegancy and Security, *viz. In taking up (ſo as their Forms will bear) the leaſt Room; and in being ſo conveniently couched as to be capable of receiving Protection from other Parts, or of giving it to one another,* e. g. *Firſt, there is the Bow-lap, where the Leaves are all laid ſome-what convexly one over another, but not plaited — but where the Leaves are not ſo thick ſet, as to ſtand in the Bow-lap, there we have the Plicature, or the Flat-lap; as in Roſe-trees,* &c. And ſo that curious Obſerver goes on ſhewing the various Foldings, to which he gives the Names of the *Duplicature, Multiplicature,* the *Fore-rowl, Back-rowl,* and *Tre-rowl,* or *Treble-rowl.* *Grew,* ib. lib. i. cap. 4. ſect. 14, *&c.* To theſe he adds ſome others, lib. iv. p. 1. cap. 1. ſect. 9. Conſult alſo *Malpig. de Gemmis,* p. 22, *&c.*

To theſe curious Foldings, we may add another noble Guard by the Interpoſition of *Films*, *&c.* of which Dr. *Grew* ſaith, there are about ſix Ways, *viz. Leaves, Surfoils, Interfoils, Stalks, Hoods,* and *Mantlings.* *Grew,* ib. and *Tab.* 41, 42. *Malpig.* ibid.

(g) In the *Flower* may be conſidered the *Empalement*, as Dr. *Grew*, the *Calix*, or *Perianthium*, as Mr. *Ray*, and others, call it, deſigned to be a Security, and Bands to the other Parts of the Flower. *Floris velut baſis & fulcimentum eſt.* Ray Hiſt. lib. i. cap. 10. Flowers, whoſe *Petala* are ſtrong (as Tulips) have no *Calix*. *Carnations*, whoſe *Petala* are long and ſlender, have an Empalement of one Piece: And others, ſuch as the

wonderful Generation and Make of the Seed *(b)*, and the great Uſefulneſs of their Fruit: I might ſhew that the Rudiments and Lineaments of the Parent-Vegetable, though never ſo large and ſpacious, is locked up in the little Compaſs of their Fruit or Seed, though ſome of theſe Seeds are ſcarce viſible to the naked Eye *(i)*. And foraſmuch as

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Knap-weeds, have it conſiſting of ſeveral Pieces, and in divers Rounds, and all with a counterchangeable Reſpect to each other, for the greater Strength and Security of themſelves, and the *Petala*, &c. they include.

The next is the *Foliation*, as Dr. *Grew*, the *Petala*, or *Folia*, as Mr. *Ray*, and others. In theſe, not only the admirable Beauty, and luxuriant Colours are obſervable, but alſo their curious *Foldings* in the *Calix*, before their Expanſion. Of which Dr. *Grew* hath theſe Varieties, *viz.* The *Cloſe-Couch*, as in *Roſes*; the *Concave-Couch*, as in *Blattaria flore albo*; the *Single-Plait*, as in *Peaſe-Bloſſoms*; the *Double Plait*, as in *Blue-Bottles*, &c. the *Couch* and *Plait* together, as in *Marigolds*, &c. the *Rowl*, as in *Ladies-Bower*; the *Spire*, as in *Mallows*; and laſtly, the *Plait* and *Spire* together, as in *Convolvulus Doronici folio*. lib. i. cap. 5. ſect. 6. and Tab. 54.

As to the *Stamina* with their *Apices*, and the *Stylus*, (called the *Attire*, by Dr. *Grew*,) they are admirable, whether we conſider their Colours, or Make, eſpecially their Uſe, if it be as Dr. *Grew*, Mr. *Ray*, and others imagine, namely, as a *Male Sperm*, to impregnate and fructify the Seed. Which Opinion is corroborated by the ingenious Obſervations of Mr. *Samuel Morland*, in *Philoſ. Tranſ.* N° 287.

Reliqua usûs alimentique gratiâ genuit [Natura] *ideoque ſecula annoſque tribuit iis. Flores verò odoreſque in diem gignit: magnâ (ut palam eſt) admonitione hominum, quæ ſpectatiſſimè floreant, celerrimè marceſcere.* Plin. Nat. Hiſt. lib. xxi. cap. 1.

(b) As to the curious and gradual Proceſs of Nature in the Formation of the Seed or Fruit of Vegetables, Cuts being neceſſary, I ſhall refer to Dr. *Grew*, p. 45. and 209. and *Malpig.* p. 57.

(i) Vetus eſt Empedoclis dogma, Plantarum ſemina Ova eſſe, ab iiſdem decidua — Ineſt in eo [Ovo vel Semine] *velut in cicatrice, non ſola viventis carina, ſed cum minimo trunco aſſurgentes partes, Gemma ſcilicet, & inſignis radicis Canus, &c.*

Malpig.

the Perpetuity and Safety of the Species depends upon the Safety of the Seed and Fruit in a great Meaſure, I might therefore take Notice of the peculiar Care the great God of Nature hath taken for the Conſervation and Safety hereof: As particularly in ſuch as dare to ſhew their Heads all the Year,

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Malpig. ibid 81. Vid. plura in tract. *de Seminum veget.* p. 14. & paſſim.

In *Malpighi*'s Life, a Debate may be ſeen between him and *Seign. Triumphetti*, the Provoſt of the Garden at *Rome*, whether the whole Plant be actually in the Seed. The Affirmative is maintained by *Malpighi*, with cogent Arguments; among which, this is one: *Non præoccupatâ mente, oculis microſcopio armatis, luſtret quæſo Phaſeolarum, ſeminalem plantulam nondum ſatam, in quâ folia ſtabilia, hæcque ampla evidenter obſervabit; in eâdem pariter gemmam, nodos, ſeu implantationes varias foliorum caulis deprehendet. Caulem inſignem fibris ligneis, & utriculorum ſeriebus conſtantem conſpicuè attinget.* And whereas S. *Triumphetti* had objected, that *Vegetatione, metamorphoſi, inediâ plantas in alias degenerare, ut exemplo plurium* [conſtat] *præcipuè tritici in lolium, & lolii in triticum verſi:* In Anſwer to this, (which is one of the ſtrongeſt Arguments againſt *Malpighi*'s Aſſertion,) *Malpighi* replies, *Nondum certum eſt de integritate, & ſucceſſu experimenti, nam facienti mihi, & amicis, tritici metamorphoſis non ceſſit. Admiſſa tamen metamorphoſi, quoniam hæc neglecta cultura, aut vitio ſoli, aut aëris contingit — ideo ex morboſo & monſtruoſo affectu non licet inferre permanentem ſtatum à Naturâ intentum. Obſervo plantas ſylveſtres culturâ varias reddi, &c.* I have more largely taken Notice of *Malpighi*'s Anſwer, becauſe he therein ſhews his Opinion about the Tranſmutation of Vegetables. *Vide Malpig. Vit.* p. 67.

So Mr. *Lewenhoeck*, after his nice Obſervations of an *Orange-Kernel*, which he made to germinate in his Pocket, &c. concludes, *Thus we ſee, how ſmall a Particle, no bigger than a coarſe Sand,* (as the Plant is repreſented) *is increaſed,* &c. *A plain Demonſtration, that the Plant, and all belonging to it, was actually in the Seed, in the young Plant, its Body, Root,* &c. Philoſ. Tranſ. N° 287. See alſo *Raii Cat. Cant.* in *Acer maj.* from Dr. *Highmore*. But in all the Seeds which I have viewed, except the *Maple*, the Plant appears the plaineſt to the naked Eye, and alſo very elegant, in the *Nux Vomica*.

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Year, how ſecurely their Flower, Seed or Fruit is locked up all the Winter, together with their Leaves and Branches, in their Gems (*k*), and well fenced

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Natura non obſervat magnitudinis proportionem inter ſemina & plantas ab iiſdem ortas, ita ut majus ſemen majorem ſemper producat plantam, minus minorem. Sunt enim in genere herbarum non pauca, quarum ſemina arborum nonnullarum ſeminibus non dico æqualia ſunt, ſed multo majora. Sic v. g. *Semina Fabæ, &c. ſemina Ulmi, &c. multis vicibus magnitudine ſuperant.* Raii ubi ſuprà, lib. i. cap. 13.

Filicem reliquaſque Capillares herbas Semine carere Veteres plerique — prodidere; quos etiam ſecuti ſunt è Recentioribus nonnulli, Dodonæus, etc. — Alii è contrà, Bauhinus, etc. Filices et congeneres ſpermatophoras eſſe contendunt; Partim quia Hiſtoria Creationis, Geneſ. ii. 12, *etc. — Hanc ſententiam veriſſimam eſſe — autopſia convincit. Fredericus Cæſius*, he ſaith, was the firſt that diſcovered theſe Seeds with the Help of a Microſcope. And ſince him, Mr. *W. C.* hath more critically obſerved them. Among other things obſerved by that ingenious Gentleman, are theſe, *Pixidulæ ſeu capſulæ ſemina continentes in pleriſque hoc genus plantis perquam exili granulo arenæ vulgaris cinereæ plus duplo minores ſunt; imò in nonnullis ſpeciebus vix tertiam quartamve arenulæ partem magnitudine æquant, veſicularum quarundam annulis aut faſciolis vermiformibus obvolutarum ſpeciem exhibentes. Nonnullæ ex his veſiculis* 100 *circiter ſemina continere deprehendebantur — adeò eximiâ parvitate ut nudo oculo prorſus eſſent inviſibilia, nec niſi microſcopii interventu detegi poſſent. — Oſmunda Regalis, quæ aliis omnibus Filicis ſpeciebus mole — antecellit — vaſcula ſeminalia obtinet æquè cum reliquis congeneribus magnitudinis — quorum immenſa et viſum fugiens parvitas cum magnitudine plantæ collata — adeo nullam gerere proportionem invenietur, ut tantam plantam è tantillo ſemine produci attentum obſervatorem meritò in admirationem rapiat.* Ray, ibid. lib. iii. p. 132. This *W. C.* was Mr. *Will. Cole*, as he owneth in a letter I have now in my Hands of his to Mr. *Ray*, of *Octob.* 18. 1684.

(*k*) *Vegetantium genus, ut debitam magnitudinem ſortiatur, et ſuæ mortalitatis jacturam ſucceſſivâ prolis eductione reparet, ſtatis temporibus novas promit partes, ut tandem emergentes Uteri, recentes edant Soboles. Emanantes igitur à caule, caudice, ramis, et radicibus novellæ hujuſmodi partes, non illico laxatæ extenduntur, ſed compendio quodam coagmentatæ intra folii*

fenced and covered there with neat and cloſe Tunicks. And for ſuch as dare not ſo to expoſe themſelves, with what Safety are they preſerved under the Coverture of the Earth, in their Root *(l)*, Seed *(m)*, or Fruit, till invited out by the kindly

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folii axillam cubantes, non parum ſubſiſtunt, Gemmæ appellantur, &c. And then that great Man goes on to ſhew the admirable various Methods of Nature, in repoſiting in that little Compaſs, ſo large a Part of a Tree or Plant, the curious Structure of the Gems, the admirable Guard afforded them, and the Leaves, Flowers, and Seed contained in them, *&c.* Of which having taken Notice before, I paſs over it now, and only refer to our Author *Malpighi*, and Dr. *Grew*, in the Places cited in *Note (f)* and *(g)*.

(l) Of *Bulbous*, and a great many more, probably of the far greater Number of *Perennial Roots* of Herbs, as *Arum*, *Rape-Crowfoot*, &c. it is very obſervable, that their Root is annually renewed, or repaired out of the Trunk or Stalk itſelf; that is to ſay, the *Baſis* of the *Stalk* continually, and by inſenſible Degrees, deſcending below the Surface of the Earth, and hiding itſelf therein, is thus, both in Nature, Place, and Office, changed into a true Root.—So in *Brownwort*, the Baſis of the Stalk ſinking down by Degrees, till it lies under Ground, becomes the upper Part of the Root; and continuing ſtill to ſink, the next Year becomes the lower Part: And the next after that, rots away; a new Addition being ſtill yearly made out of the Stalk, as the elder Parts yearly rot away. *Grew*, ibid. lib. ii. p. 59. *ubi plura vid.*

(m) How ſafe and agreeable a Conſervatory the Earth is to Vegetables, more than any other, is manifeſt from their rotting, drying, or being rendered infecund in the Waters, or the Air; but in the Earth their Vigour is long preſerved. Thus Seeds particularly, Mr. *Ray* thinks, ſome may probably retain their Fecundity for ten Years, and others loſe it in five; but, ſaith he, *In terræ gremio latitantia, quamvis tot caloris, frigoris, humoris, & ſiccitatis varietatibus ibidem obnoxia, diutiùs tamen (ut puto) fertilitatem ſuam tuentur quàm ab hominibus diligentiſſimè cuſtodita; nam & ego & alii ante me multi obſervârunt Sinapeos vim magnam enatam in aggeribus foſſarum recèns factis inque areis gramineis effoſſis, ubi poſt hominum memoriam nulla unquam Sinapeos ſeges ſuccreverat. Quam tamen non ſpontè ortam ſuſpicor, ſed è ſeminibus in terrâ per tot annos reſtantis etiam prolificis.* Ray Hiſt. Plant. lib. i. cap. 13.

Warmth of the Spring! And when the whole Vegetable Race is thus called out, it is very pretty to obſerve the Methods of Nature in guarding thoſe inſenſitive Creatures againſt Harms and Inconveniencies, by making ſome (for Inſtance) to lie down proſtrate, and others, to cloſe themſelves up *(n)* upon the Touch of Animals, and the moſt to ſhut up their Flowers, their Down *(o)*, or other their like Guard, upon the Cloſe and Cool of the Evening, by Means of Rain, or other Matters that may be prejudicial to the tender Seed.

And now to theſe Conſiderations relating to the Seed, I might add the various Ways of Nature in diſſipating and ſowing it, ſome being, for this End, winged with light Down, or Wings, to be con-

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(n) Plantæ nonnullæ Æſchynomenæ Veteribus dictæ, Recentioribus Vivæ, & Senſitivæ, & Mimoſæ, haud obſcurâ ſensûs indicia produnt; ſiquidem folia earum manu aut baculo tacta, & paululum compreſſa, pleno etiam meridie, ſplendente Sole, illico ſe contrahunt; in nonnullis etiam ſpeciebus cauliculi teneriores concidunt, & velut marceſcunt; quod idem ab aëre frigidiore admiſſa patiuntur. Ray Hiſt. Plant. tom. i. lib. xviii. App. ſ. 2. c. 2. p. 978.

(o) I have obſerved that many, if not moſt Vegetables, do expand their Flowers, Down, &c. in warm Sun-ſhiny Weather, and again cloſe them towards Evening, or in Rain, &c. eſpecially at the Begining of Flowering, when the Seed is young and tender; as is manifeſt in the Down of *Dandelion*, and other Downs; and eminently in the Flowers of *Pimpernel*; the opening and ſhutting of which, are the Countryman's Weather-wiſer; whereby *Gerard* ſaith, he foretelleth what Weather ſhall follow the next Day; for, ſaith he, *If the Flowers be cloſe ſhut up, it betokeneth Rain and foul Weather; contrarywiſe, if they be ſpread abroad, fair Weather.* Ger. Herb. book ii. chap. 183.

Eſt et alia [arbor in Tylis] *ſimilis, folioſior tamen, roſeique floris; quem noctu comprimens, aperire incipit Solis exortu, meridie expandit. Incolæ dormire eam dicunt.* Plin. Nat. Hiſt. lib. xii. cap. 11.

veyed about by the Winds; others being laid in elaſtick, ſpringy Caſes, that when they burſt and crack, dart their Seed at convenient Diſtances, performing thereby the Part of a good Huſbandman (*p*); others by their agreeable Taſte and Smell,

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(*p*) *So ſoon as the Seed is ripe, Nature taketh ſeveral Methods for its being duly ſown; not only in the opening of the* Uterus, *but alſo in the Make of the Seed itſelf. For, firſt, The Seeds of many Plants, which affect a peculiar Soil or Seat, as of* Arum, Poppy, &c. *are heavy and ſmall enough, without farther Care, to fall directly down into the Ground—But if they are ſo large and light, as to be expoſed to the Wind, they are often furniſhed with one or more Hooks, to ſtay them from ſtraying too far from the proper Place—So the Seeds of* Avens *have one ſingle Hook; thoſe of* Agrimony *and* Gooſegraſs, *many: both the former loving a warm Bank; the latter, an Hedge for its Support. On the contrary, many Seeds are furniſhed with Wings or Feathers; partly with the Help of Wind to carry them, when ripe, from off the Plant, as of* Aſh, &c.—*and partly to enable them to make their Flight more or leſs abroad, that ſo they may not, by falling together, come up too thick; and that if one ſhould miſs a good Soil or Bed, another may hit. So the Kernels of* Pine *have Wings—yet ſhort—whereby they fly not into the Air, but only flutter upon the Ground. But thoſe of* Typha, Dandelion, *and moſt of the pappous Kind—have long numerous Feathers, by which they are wafted every Way.—Again, there are Seeds which are ſcattered not by flying abroad, but by being either ſpirted or flung away. The firſt of thoſe are Wood-ſorrel, which having a running Root, Nature ſees fit to ſow the Seeds at ſome Diſtance. The doing of which is effected by a white ſturdy Cover, of a tendinous or ſpringy Nature.—This Cover, ſo ſoon as it begins to dry, burſts open on one Side, in an Inſtant, and is violently turned Inſide outward—and ſo ſmartly throws off the Seed. The Seeds of* Harts-tongue *is flung or ſhot away—by the curious Contrivance of the Seed-caſe, as in* Codded Aſmart, *only there the Spring moves and curls inward, but here outward,* viz. *Every Seed-caſe,—is of a ſpherick Figure, and girded about with a ſturdy Spring.—The Surface of the Spring reſembles a fine Skrew.—So ſoon as—this Spring is become ſtark enough, it ſuddenly breaks the Caſe into two Halves, like two little Cups, and ſo flings the Seed.* Grew, ib. p. 199. and in Tab. 72. all theſe admirable Artifices are handſomely repreſented.

Smell, and ſalutary Nature, inviting themſelves to be ſwallowed, and carried about by the Birds, and thereby alſo fertilized by paſſing through their Bodies;

Quin ſi quantitas modica ſeminum (Filicis Phyllitidis quoque) *à foliis in ſubjectam chartæ mundæ — ſchedam decutiatur, detergaturve, & deinde in acervum converratur, veſicularum ſeminalium plurimis unà diſſilientibus, & ſibi invicem alliſis, acervulus variè moveri per partes videbitur, non ſecus ac ſi Syrenibus aut iſtiuſmodi beſtiolis repletus eſſet — quin ſi locus tranquillus ſit, aure proximè admotâ, crepitantium inter rumpendum vaſculorum ſonitus — percipietur; & ſi microſcopio chartam oculis oberres, ſemina per eam undique ſparſa, & ad notabilem ab acervo diſtantiam projecta comperies.* Ray, ibid. p. 132.

The admirable Contrivance of Nature in this Plant, is moſt plain: For the Seed-Veſſels being the beſt Preſerver of the Seed; it is there kept from the Injuries of Air and Earth, till it be rainy, when it is a proper Time for it to grow, and then it is thrown round the Earth, as Grain by a ſkilful Sower. — When any Wet touches the End of the Seed Veſſels, with a ſmart Noiſe and ſudden Leap it opens itſelf, and with a Spring ſcatters its Seed to a pretty Diſtance round it, where it grows. Dr. Sloane Voy. to Jamaica, p. 150. of the *Gentianella flore cæruleo,* &c. or *Spirit-Leaf.*

The Plants of the *Cardamine-Family*, and many others, may be added here, whoſe Cods fly open, and dart out their Seed, upon a ſmall Touch of the Hand. But the moſt remarkable Inſtance is in the *Cardamine impatiens, Cujus Siliquæ* (ſaith Mr. *Ray) vel leviter tactæ, actutùm ejaculantur* [Semina] *imò quod longè mirabilius videtur, etſi ſiliquas non tetigeris, ſi tamen manum velut tacturus proximè admoveas, ſemina in appropinquantem evibrabunt; quod tum Moriſonus ſe ſæpius expertum ſcribit, tum Johnſtonus apud Gerardum verum eſſe affirmat.* Hiſt. Plant. lib. xvi. cap. 20.

Neither is this Proviſion made only for Land-Vegetables, but for ſuch alſo as grow in the Sea. Of which I ſhall give an Inſtance from my before-commended Friend, Dr. *Sloane: As to the Fuci, — their Seed hath been diſcovered, (and ſhewed me firſt,) by the Induſtry of the ingenious Herbariſt, Mr.* Sam. Doody, *who found on many of this Kind, ſolid Tubercles, or Riſings, in ſome Seaſons, wherein were lodged ſeveral round Seeds, as big as Muſtard-Seed, which, when ripe, the outward Membrane of the Tubercle breaking, leaveth the Seed to float up and down with the Waves. The Seed coming near Stones,* dies *(q)*; and others not thus taken Care of, do many of them by their Uſefulneſs in human Life, invite the Huſbandman and Gardener carefully to ſow and nurſe them up.

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Stones, or any ſolid Foundation, by means of a Mucilage it carries with it, ſticks to them, and ſhoots forth Ligulæ *with Branches, and in Time comes to its Perfection and Magnitude.* Sloane Voy. Jamaica, p. 60.

But although Mr. *Doody* had hinted, and conjectured at the Thing, yet the firſt that diſcovered the Seeds in *Fuci*, was the before-commended Dr. *Tancred Robinſon*; as may be ſeen by comparing what Mr. *Ray* ſaith in his *Synopſ. Stirp. Brit.* p. 6. with his *Append. Hiſt.* p. 1849. Beſides which *Fuci*, the Dr. tells me, he obſerved Veſſels and Seed in *Coralloid Shrubs*, as alſo in ſeveral *Fungi*, not only in the Species of *Crepitus Lupi*, but alſo between the *Lamellæ* of other Species, and in that ſubterraneous Kind called *Truffles*, whoſe Seed and Veſſels open in the Cortex, at ſome Seaſons he ſaith, like that of Mallows in Shape.

As to the *Crepitus Lupi*, I have more than once examined their Powder, with thoſe excellent Microſcopes of Mr. *Wilſon*'s Make: But the moſt ſatisfactory View Mr. *Wilſon* himſelf gave me; by which I found the Seeds to be ſo many exceeding ſmall *Puff-Balls*, with round Heads, and longer than ordinary ſharp-pointed Stalks, as if made on purpoſe to prick eaſily into the Ground. Theſe Seeds are intermixed with much duſty Matter, and become hurtful to the Eyes, probably by their ſharp Stalks pricking and wounding that tender Organ.

(q) The antient Naturaliſts do generally agree, that *Miſſeltoe* is propagated by its Seeds carried about by, and paſſing through the Body of Birds. Thus *Theophraſtus de Cauſ. Plant.* lib. ii. cap. 24. Τὸ δὲ ἀπὸ τῆς ὀρνίθων, &c. *Initium verò à paſtu avium: — Quippe Viſco detracto confectóque in alveis, quod frigidiſſimum eſt, ſemen cum excremento purum dimittitur, & factâ mutatione aliquâ in arbore Stercoris causâ pullulat, erumpitque, &c.* So alſo *Pliny* ſaith, viz. *Omnino autem ſatum* [Viſcum] *nullo modo naſcitur, nec niſi per alvum Avium redditum, maximè Palumbis ac Turdi. Hæc eſt natura, ut niſi maturatum in ventre Avium, non proveniat.* Plin. Nat. Hiſt. lib. xvi. cap. 44. Whether what *Theophraſtus* and *Pliny* affirm, be conducive to the better fertilizing the Seeds of *Miſſeltoe*, I know not; but that it is not of abſolute Neceſſity, I can affirm upon mine own Experience, having ſeen

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To this ſo ſingular a Care about the Propagation and Conſervation of the Species of Vegetables, I might add the nice Proviſion that is made for their Support and Aid, in ſtanding and growing, that they may keep their Heads above Ground, and not be rotted and ſpoiled in the Earth themſelves, nor thereby annoy us; but, on the contrary,

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the Seeds germinate, even in the Bark of Oak. But although they ſhot above an Inch, and ſeemed to root in the Tree, yet they came to nothing, whether deſtroyed by Ants, &c. which I ſuſpected, or whether diſagreeing with the Oak, I know not. But I ſince find the Matter put out of doubt by Mr. *Doody*; which ſee in Mr. *Ray*'s *Hiſt. Plant. App.* p. 1918.

Nutmegs are ſaid to be fertilized after the ſame Manner, as *Tavernier* ſaith was confirmed to him by Perſons that lived many Years in thoſe Parts; whoſe relation was: The *Nutmeg* being ripe, ſeveral Birds come from the Iſlands towards the South, and devour it whole, but are forced to throw it up again, before it be digeſted: And that the *Nutmeg*, then beſmeared with a viſcous Matter, falling to the Ground, takes Root, and produces a Tree, which would never thrive, was it planted. *Tavern. of the Commod. of the G.* Mogul. And Monſieur *Thevenot*, in his Travels to the *Indies*, gives this Account: The Tree is produced after this Manner; there is a Kind of Birds in the Iſland, that having picked off the green Huſk, ſwallow the Nuts, which having been ſome Time in their Stomach, they void by the ordinary Way; and they fail not to take rooting in the Place where they fall, and in Time grow up to a Tree. This Bird is ſhaped like a *Cuckow*; and the *Dutch* prohibit their Subjects, under Pain of Death, to kill any of them. *Vide* Sir *T. Pope-Blunt*'s *Nat. Hiſt.*

But Mr. *Ray* gives a ſomewhat different Account: *Hunc fructum* [Nucem Moſchatam] *variæ quidem aves depaſcuntur, ſed maximè Columbæ genus album & parvum, quæ dehiſcente nucamento, illectæ ſuavitate Macis, hunc cum Nuce eripiunt et devorant, nec niſi repletâ ingluvie capaciſſimâ ſaginam deſerant. Noſtrates ibi mercatores Columbis iſtis* Nut-eaters *ſive Nucivoris nomen impoſuerunt. Quas autem vorant Nuces, poſt integras per alvum reddunt. Redditæ citiùs deinde germinant, utpote præmaceratæ fervore Ventriculi. Arbores inde natæ ceu præcociores, facilè ſunt corruptioni obnoxiæ fructumque ferunt cæteris multo viliorem, et hâc causâ neglectum incolis contemtumque, præter Macin, quem ad adulterandum meliorem adhibent.* Ray Hiſt. Plant. lib. xxvii. cap. 4.

miniſter to all their Ends, and our Uſes; to afford us Houſes, Utenſils, Food (*r*), Phyſick, Cloathing, yea, Diverſion too, by the Beauty of their Looks, by the Fragrancy of their Smell, by creating us pleaſant Shades againſt the ſcorching Beams of Summer, and ſkreening us againſt the piercing Winds, and Cold of Winter (*s*).

And it is very obſervable what admirable Proviſions are made for this Purpoſe of their Support and Standing, both in ſuch as ſtand by their own Strength, and ſuch as need the Help of others. In ſuch as ſtand by their own Strength, it is by Means of the ſtronger and more ligneous Parts,

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(*r*) *Arbores blandioribus fruge ſuccis hominem mitigavere. Ex iis recreans membra Olei liquor, vireſque potus Vini; tot denique ſapores annui ſponte Venientes: & menſæ depugnetur licèt earum cauſa cum feris, & paſti naufragorum corporibus piſces expetantur; etiamnum tamen ſecundæ. Mille præterea ſunt uſus earum, ſine quibus vita degi non poſſit. Arbore ſulcamus maria, terraſque admovemus, arbore exædificamus tecta.* Plin. Nat. Hiſt. lib. xii. cap. 1.

(*s*) *Plantarum Uſus latiſſimè patet, & in omni vitæ parte occurrit. Sine illis lautè, ſine illis commodè non vivitur, at nec vivitur omnino: Quæcunque ad victum neceſſaria ſunt, quæcunque ad delicias faciunt, è locupletiſſimo ſuo penu abundè ſubminiſtrant. Quanto ex iis menſa innocentior, mundior, ſalubrior quàm ex Animalium cæde & laniena? Homo certè naturâ Animal carnivorum non eſt; nullis ad prædam & rapinam armis inſtructum, non dentibus exertis & ſerratis, non unguibus aduncis. Manus ad fructus colligendos, dentes ad mandendos comparati. Non legimus ei ante Diluvium carnes ad eſum conceſſas. At non victum tantùm nobis ſuppeditant, ſed & Veſtitum, & Medicinam & Domicilia aliaque ædificia, & Navigia, & Supellectilem, & Focum, & Oblectamenta Senſuum Animique: Ex his naribus odoramenta & ſuffumigia parantur. Horum floris inenarrabili colorum & Schematum varietate, & elegantiâ, oculos exhilarant, ſuaviſſima odorum quos expirant fragrantia ſpiritus recreant. Horum fructus gulæ illecebræ menſas ſecundas inſtruunt, & languentem appetitum excitant. Taceo virorum amæniſſimum oculis amicum, quem per prata paſcua agros, ſylvas ſpatiantibus objiciunt, & umbras quas contra æſtum & ſolis ardores præbent.* Ray. ib. lib. i. cap. 24. p. 46.

(equivalent to the Bones in Animals,) being made not inflexible, as Bones; becauſe they would then be apt to break; but of a yielding elaſtick Nature, to eſcape and dodge the Violence of the Winds; and by Means alſo of the Branches ſpreading handſomely and commodiouſly about, at an Angle of about 45 *gr.* by which Means they equally fill up, and at the ſame Time make an Æquilibration of the Top (*t*).

And as for ſuch Vegetables as are weak, and not able to ſupport themſelves, it is a wonderful Faculty they have, ſo readily and naturally to make Uſe of the Help of their Neighbours, embracing and climbing up upon them (*u*), and uſing them as

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(*t*) All Vegetables of a tall and ſpreading Growth, ſeem to have a natural Tendency to a hemiſpherical Dilation, but generally confine their Spreading within an Angle of 90 *gr.* as being the moſt becoming and uſeful Diſpoſition of its Parts and Branches. Now the ſhorteſt Way to give a moſt graceful and uſeful filling to that ſpace of dilating and ſpreading out, is to proceed in ſtrait Lines, and to diſpoſe of thoſe Lines, in a Variety of Parallels, *etc.* And to do that in a quadrantal Space, *etc.* there appears but one Way poſſible, and that is, to form all the Interſections, which the Shoots and Branches make, with Angles of 45 *gr.* only. And I dare appeal to all, if it be not in this Manner, almoſt to a Nicety, obſerved by Nature, *etc.* A viſible Argument that the plaſtick Capacities of Matter are governed and diſpoſed by an All-wiſe and Infinite Agent, the Native Strictneſſes and Regularities of them, plainly ſhewing from whoſe Hand they come. *Account of the Origine and Format. of Foſſ. Shells,* &c. *Print.* Lond. 1705. p. 38, 41.

(*u*) *In Hederâ, ſurculi & rami hinc inde claviculas, quaſi radiculas emittunt, quæ parietibus, vel occurrentibus arboribus veluti digitis firmantur, & in altum ſuſpenduntur. Hujuſmodi radiculæ ſubrotundæ ſunt, & pilis cooperiuntur; & quod mirum eſt, glutinoſum fundunt humorem, ſeu Terebinthinam, quâ arctè lapidibus noctuntur & agglutinantur. — Non minori induſtriâ Natura utitur in Vite Canadenſi, &c.* The admirable and curious Make of whoſe Tendrels and their Feet, ſee in the illuſtrious Author, *Malpig. de Capreolis, &c.* p. 48.

as Crutches to their feeble Bodies: Some by their odd convolving Faculty, by twiſting themſelves, like a Screw, about others; ſome advancing themſelves, by catching and holding with their curious *Claſpers* and *Tendrels*, equivalent to the Hands; ſome by ſtriking in their rooty Feet; and others by the Emiſſion of a natural Glue, cloſely and firmly adhering to ſomething or other that adminiſters ſufficient Support unto them. All which various Methods being ſo nicely accommodated to the Indigencies of thoſe helpleſs Vegetables, and not to be met with in any beſides, is a manifeſt Indication of their being the Contrivance and Work of the Creator, and that his infinite Wiſdom and Care condeſcends, even to the Service, and well-being of the meaneſt, moſt weak, and helpleſs inſenſitive Parts of the Creation.

In the laſt Place, to the Uſes already hinted at, I might add a large Catalogue of ſuch among Vegetables, as are of peculiar Uſe and Service to

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Claſpers are of a Compound Nature, between that of a Root and a Trunk. Their Uſe is ſometimes for Support only, as in the Claſpers of Vines, Briony, *etc.* whoſe Branches being long, ſlender, and fragile, would fall by their own Weight, and that of their Fruit; but theſe Claſpers taking hold of any thing that is at hand; which they do by a natural Circumvolution which they have; (thoſe of Briony have a retrograde Motion about every third Circle, in the Form of a double Claſp; ſo that if they miſs one Way, they may catch the other.) Sometimes the Uſe of Claſpers is alſo for a Supply, as in the Trunk Roots of Ivy; which being a Plant that mounts very high, and being of a cloſer and more compact Subſtance than that of Vines, the Sap would not be ſufficiently ſupplied to the upper Sprouts, unleſs theſe aſſiſted the Mother-Root; but theſe ſerve alſo for Support too. Sometimes alſo they ſerve for Stabiliment, Propagation, and Shade; for the firſt of theſe ſerve the Claſpers of Cucumbers; for the ſecond, thoſe, or rather the Trunk-Roots of *Chamomil*; and for all three the Trunk-Roots of *Strawberries*. *Harris Lex. Tech. in verb. Claſpers.*

the World, and ſeem to be deſigned as it were on Purpoſe, by the moſt merciful Creator, for the Good of Man, or other Creatures *(w)*. Among *Grain*, I might name the great Fertility *(x)* of ſuch as ſerves for Bread, the eaſy Culture and Propagation thereof, and the Agreement of every Soil and Climate to it. Among Trees, and Plants, I might Inſtance in ſome that ſeem to be deſigned, as it were, on Purpoſe, for almoſt every Uſe *(y)*, and

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(w) Vegetables afford not only Food to Irrationals, but alſo Phyſick, if it be true which *Ariſtotle* ſaith, and after him *Pliny*; which latter, in his 8th *Book*, *Chap*. 27. ſpecifies divers Plants made uſe of as Specificks, by divers, both Beaſts and Birds: As *Dittany* by wounded *Deer*; *Celandine* by *Swallows*, to cure the ſore Eyes of their Young, *etc*. And if the Reader hath a Mind to ſee more Inſtances of this Nature, (many of them fanciful enough,) he may conſult *Merſenne in Geneſ*. p. 933.

(x) See before *Book* IV. *Chap*. 11. *Note (b)*.

(y) Planta hæc unica [Aloe Americana] *inquit Fr. Hernandez, quicquid vitæ eſſe poteſt neceſſarium præſtare facilè poteſt, ſi eſſet rebus humanis modus. Tota enim illa lignorum ſepiendorumque agrorum uſum præſtat, caules tignorum, folia verò tecta tegendi imbricum, lancium: eorundem nervuli, & fibræ eundem habent uſum ad linteamina, calceos, & veſtimenta conficienda quem apud nos Linum, Cannabis, Goſſipium, &c. E mucronibus fiunt clavi, aculei, ſubulæ, quibus perforandis auribus, macerandi corporis gratiâ, Indis uti mos erat cùm Dæmonum vacarent cultui; item aciculæ, acus, tribuli militares & raſtilla idonea pectendis ſubtegminibus. Præterea è ſucco mananti, cujus evulſis germinibus internis foliiſve tenerioribus cultis* [Yztlinis] *in mediam cavitatem, ſtillat planta, unica ad* 50 *interdum amphoras (quod dictu eſt mirabile) Vina, Mel, Acetum ac Saccharum parantur* [The Methods of which he tells.] *Idem ſuccus menſes ciet, alvum lenit, Urinam evocat, Renes et Veſicam emundat. E radice quoque Reſtes fiunt firmiſſimæ. Craſſiores foliorum partes, truncuſque, decocta ſub terrâ, edendo ſunt apta, ſapiuntque Citrea fruſta ſaccharo condita: quin et vulnera recentia mirè conglutinant.—Folia quoque aſſa et affecto loco impoſita convulſionem curant, ac dolores leniunt (præcipuè ſi ſuccus ipſe calens bibatur) quamvis ab Indicâ proficiſcantur lue, ſenſum hebetant, atque torporem inducunt. Radicis ſuccus Luem Veneream curat apud Indos, ut Dr.*

Palmer.

and Convenience; ſome to heal the moſt ſtubborn and dangerous Diſtempers *(z)*, to alleviate and eaſe the Pains *(aa)* of our poor infirm Bodies, all the World over: And ſome deſigned for the peculiar Service and Good of particular Places, either to cure ſuch Diſtempers as are peculiar to them, by growing more plentifully there than elſewhere *(bb)*; or

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Palmer. Ray ibid. lib. xxi. cap. 7. See alſo Dr. *Sloane*'s Voyage to *Jamaica*, p. 247.

There are alſo two Sorts of *Aloe* beſides, mentioned by the ſame Dr. *Sloane*, one of which is made uſe of for Fiſhing-Lines, Bow-ſtrings, Stockings, and Hammocks. Another hath Leaves that hold Rain-water, to which Travellers, *etc.* reſort to quench their Thirſt, in Scarcity of Wells, or Waters, in thoſe dry Countries. Ibid. p. 249.

(z) For Inſtance here, I ſhall name the *Cortex Peruvianus*, which Dr. *Morton* calls *Antidotus in levamen ærumnarum vitæ humanæ plurimarum divinitus conceſſa.* De Febr. Exer. v. cap. 3. *In Sanitatem Gentium proculdubio à Deo O. M. conditus. Cujus gratiâ, Arbor vitæ, ſiqua alia, jure meritò appellari poteſt.* Id. ib. cap. 7. *Eheu! quot convitiis Herculea et divina hæc Antidotus jactabatur?* Ibid.

To this (if we may believe the *Ephemer. German. Ann.* 12. *Obſer.* 74. and ſome other Authors) we may add *Triſolium Paludoſum*, which is become the *Panacea* of the *German* and Northern Nations.

(aa) Pro doloribus quibuſcunque ſedandis præſtantiſſimi ſemper uſus Opium habetur; quamobrem meritò Nepenthe *appellari ſolet, et remedium verè divinum exiſtit. Et quidem ſatis mirari vix poſſumus, quomodo urgente viſceris aut membri cujuſpiam torturâ inſigni, & intolerabili cruciatu, pharmacum hoc, incantamenti inſtar, levamen et ἀναλγησίαν ſubitam, immò interdum abſque ſomno, aut ſaltem priùs quàm advenerit, concedit. Porrò adhuc magis ſtupendum eſt, quod donec particulæ Opitiacæ operari, et potentiam ſuam narcoticam exerere continuant, immò etiam aliquamdiu poſtquàm ſomnus finitur, ſumma allevatio, et indolentia in parte affectâ perſiſti.* Willis, Phar. Rat. Par. i. S. 7. cap. 1. ſect. 15.

(bb) Tales Plantarum ſpecies in quacunque regione à Deo creantur quales hominibus et animalibus ibidem natis maximè conveniunt; imò ex plantarum naſcentium frequentiâ ſe fere animadvertere poſſe quibus morbis [endemiis] *quælibet regio ſubjecta ſit, ſcribit Solenander. Sic apud Danos, Friſios, Hollandos, quibus,* Scor-

or elſe to obviate ſome Inconvenience there, or to ſupply ſome conſtant Neceſſity, or Occaſion, not poſſible, or at leaſt not eaſy, to be ſupplied any other Way *(cc)*. It is, for Inſtance, an admirable

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Scorbutus frequens, Cochlearia copioſè provenit. Ray, Hiſt. Pl. lib. xvi. cap. 3.

To this may be added, *Elſner*'s Obſervations concerning the Virtues of divers Things, in his Obſervations *de Vincetoxico Scrophularum remedio*, F. Germ. T. 1. Obſ. 57.

John Benorovinus, a Phyſician of *Dort*, may be here conſulted, who wrote a Book on Purpoſe to ſhew, that every Country hath every Thing ſerving to its Occaſions, and particularly Remedies afforded to all the Diſtempers it is ſubject unto. See *Benor.* 'Αυτάρκεια. *Batav. ſive Introd. ad Medic. indigenam.*

(cc) The Deſcription Dr. *Sloane* gives of the *Wild-Pine* is, That its Leaves are chanelled, ſit to catch and convey Water down into their Reſervatories; that theſe Reſervatories are ſo made as to hold much Water, and cloſe at Top when full, to hinder its Evaporation; that theſe Plants grow on the Arms of the Trees in the Woods every where [in thoſe Parts] as alſo on the Barks of their Trunks. And one Contrivance of Nature in this Vegetable, (he ſaith,) is very admirable. The Seed hath long and many Threads of *Tomentum*, not only that it may be carried every where by the Wind — but alſo, that it may by thoſe Threads, when driven through the Boughs, be held faſt, and ſtick to the Arms, and extant Parts of the Barks of Trees. So ſoon as it ſprouts or germinates, although it be on the under Part of a Bough — its Leaves and Stalk riſe perpendicular, or ſtrait up, becauſe if it had any other Poſition, the Ciſtern (before-mentioned, by which it is chiefly nouriſhed —) made of the hollow Leaves, could not hold Water, which is neceſſary for the Nouriſhment and Life of the Plant. — In Scarcity of Water, this Reſervatory is neceſſary and ſufficient, not only for the Plant itſelf, but likewiſe is very uſeful to Men, Birds, and all Sorts of Inſects, whither they come in Troops, and ſeldom go away without Refreſhment. *Id. ib.* p. 188. and *Phil. Tranſ.* N°251. where a Figure is given of this notable Plant, as alſo in *Lowthorp*'s *Abridg.* vol. ii. p. 669.

The *Wild-Pine*, ſo called, *etc.* hath Leaves that will hold a Pint and a half, or Quart of Rain-Water; and this Water refreſhes the Leaves, and nouriſhes the Root. When we find theſe Pines, we ſtick our Knives into the Leaves, juſt above the Root, and that lets out the Water, which we catch in our Hats, as able Proviſion made for ſome Countries ſubject to Drought, that when the Waters every where fail, there are Vegetables which contain not only Moiſture enough to ſupply their own Vegetation and Wants, but afford Drink alſo both to Man and other Creatures, in their great Extremities *(dd)*; and a great deal more might be inſtanced in of a like Nature, and Things that bear ſuch plain Impreſſes of the Divine Wiſdom and Care, that they manifeſt the Superintendence of the infinite Creator.

Thus I have given a Sketch of another Branch of the Creation, which (although one of the mean-

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as I have done many Times to my great Relief. *Dampier's Voy. to Campeachy,* chap. ii. p. 56.

(dd) Navarette tells us of a Tree called the *Bejuco,* which twines about other Trees, with its End hanging downwards; and that Travellers cut the Nib off it, and preſently a Spout of Water runs out from it, as clear as Cryſtal, enough, and to ſpare, for ſix or eight Men. I drank (ſaith he,) to my Satiſfaction of it, found it cool and ſweet, and would drink it as often as I found it in my way. It is a Juice and natural Water. It is the common Relief of the Herdſmen on the Mountains; when they are thirſty, they lay hold on the *Bejuco,* and drink their Fill. *Collect. of Voy. and Trav.* vol. i. *in the Suppl. to* Navarette's *Account of* China, p. 355.

The *Waterwith* of *Jamaica* hath the ſame Uſes, concerning which, my before-commended Friend, Dr. *Sloane,* favoured me with this Account from his Original Papers: *This Vine growing on dry Hills, in the Woods, where no Water is to be met with, its Trunk, if cut into Pieces two or three Yards long, and held by either End to the Mouth, affords ſo plentifully a limpid, innocent, and refreſhing Water, or Sap, as gives new Life to the droughty Traveller or Hunter. Whence this is very much celebrated by all the Inhabitants of theſe Iſlands, as an immediate Gift of Providence to their diſtreſſed Condition.*

To this we may add what Mr *Ray* takes Notice of concerning the *Birch-Tree. In initiis Veris antequam folia prodiere, vulnerata dulcem ſuccum copioſè effundit, quem ſiti preſſi Paſtores in ſylvis ſæpenumerò potare ſolent. Nos etiam non ſemel eo liquore recreati ſumus, cùm herbarum gratiâ vaſtas peragravimus ſylvas, inquit Tragus.* Raii Cat. Plant. circa Cantab. in Betula.

eſt, yet, if it was accurately viewed, would abundantly manifeſt itſelf to be the Work of GOD. But becauſe I have been ſo long upon the other Parts, although leſs than they deſerve, I muſt therefore content myſelf with thoſe general Hints I have given; which may however ſerve as Specimens of what might have been more largely ſaid about this inferior Part of the animated Creation.

As to the *Inanimate Part*, ſuch as Stones, Minerals, Earth, and ſuch like, that which I have already ſaid in the Beginning ſhall ſuffice.

BOOK XI.

Practical Inferences from the foregoing SURVEY.

HAVING, in the preceding BOOKS, carried my Survey as far as I care at preſent to engage myſelf, all that remaineth, is to draw ſome Inferences from the foregoing Scene of the Great Creator's Works, and ſo conclude this Part of my intended Work.

CHAP. I.

That God's Works are Great and Excellent.

THE firſt Inference I ſhall make, ſhall be by way of Confirmation of the Text, that *the Works of the Lord are great* (a). And this is neceſſary to be obſerved, not againſt the Atheiſt only, but all other careleſs, incurious Obſervers of God's Works.

(a) *Equidem ne laudare quidem ſatis pro merito poſſum ejus Sapientiam ac Potentiam, qui animalia fabricatus eſt. Nam ejuſmodi opera non Laudibus modò, verùm etiam Hymnis ſunt majora, quæ priuſquam inſpexiſſemus, fieri non poſſe perſuaſum habeamus, conſpicati vero, falſos nos opinione fuiſſe comperimus.* Galen. de Uſu Part. lib. vii, cap. 15.

Many of our uſeful Labours, and ſome of our beſt modern Books ſhall be condemned with only this Note of Reproach, That they are about trivial Matters (*b*), when in truth they are ingenious and noble Diſcoveries of the Works of GOD. And how often will many own the World in General to be a Manifeſtation of the infinite Creator, but look upon the ſeveral Parts thereof as only Toys and Trifles, ſcarce deſerving their Regard? But in the foregoing (I may call it) tranſient View I have given of this lower, and moſt ſlighted Part of the Creation, I have, I hope, abundantly made out, that all the Works of the LORD, from the moſt regarded, admired, and praiſed, to the meaneſt and moſt ſlighted, are great and glorious Works, incomparably contrived, and as admirably made, fitted up and placed in the World. So far then are any of the Works of the LORD, (even thoſe eſteemed the meaneſt) from deſerving to be diſregarded, or contemned by us (*c*), that on the contrary they deſerve (as ſhall be ſhewn in the next Chapter) to be *ſought out*, *enquired after*, and *curiouſly*, and *diligently pried into* by us; as I have ſhewed the Word in the Text implies.

(*b*) *Non tamen pigere debet Lectores, ea intelligere, quemadmodum ne Naturam quidem piguit ea reipsâ efficere.* Galen. ibid. lib. xi. fin.

(*c*) *An igitur etiamſi quemadmodum Natura hæc, et ejuſmodi, ſummâ ratione ac providentiâ agere potuit, ita et nos imitari aliquando poſſemus? Ego vero exiſtimo multis noſtrum ne id quidem poſſe, neque enim artem Naturæ exponunt: Eo enim modo omnino eam admirarentur, ſin minùs, eam ſaltem non vituperarent.* Galen. ibid. lib. x. cap. 3.

CHAP. II.

That God's Works ought to be enquired into, and that ſuch Enquiries are commendable.

THE *Creator* doubtleſs did not beſtow ſo much Curioſity, and exquiſite Workmanſhip and Skill upon his Creatures, to be looked upon with a careleſs, incurious Eye, eſpecially to have them ſlighted or contemned; but to be admired by the rational Part of the World, to magnify his own Power, Wiſdom, and Goodneſs, throughout all the World, and the Ages thereof. And therefore we may look upon it as a great Error, not to anſwer thoſe Ends of the infinite *Creator*, but rather to oppoſe and affront them. On the contrary, my Text commends God's Works, not only for being Great, but alſo approves of thoſe curious and ingenious Enquirers, that *ſeek them out*, or *pry into them.* And the more we pry into, and diſcover of them, the greater and more glorious we find them to be, the more worthy of, and the more expreſly to proclaim their great *Creator*.

Commendable then are the Reſearches, which many amongſt us have, of late Years, made into the Works of Nature, more than hath been done in ſome Ages before. And therefore when we are aſked, *Cui Bono?* To what Purpoſe ſuch Enquiries, ſuch Pains, ſuch Expence? The anſwer is eaſy, It is to anſwer the Ends for which God beſtowed ſo much Art, Wiſdom, and Power about them, as well as given us Senſes to view and ſurvey them; and an Underſtanding and Curioſity to ſearch into them: It is to follow and trace him, when and whither he leads us, that we may ſee and admire his Handywork ourſelves, and ſet it forth to others, that they may ſee, admire, and praiſe it alſo. I ſhall then conclude this Inference with what *Elihu* recommends, *Job* xxxvi. 24, 25. *Remember that thou magnify his Work, which Men behold. Every Man may ſee it, Men may behold it afar off.*

CHAP. III.

That God's Works are manifeſt to all: Whence the Unreaſonableneſs of Infidelity.

THE concluding Words of the preceding Chapter ſuggeſt a third Inference, that the Works of GOD are ſo viſible to all the World, and withal ſuch manifeſt Indications of the Being and Attributes of the Infinite Creator, that they plainly argue the Vileneſs and Perverſeneſs of the Atheiſt, and leave him inexcuſable. For it is a Sign a Man is a wilful, perverſe Atheiſt, that will impute ſo glorious a Work, as the Creation is, to any Thing, yea, a mere *Notking*, (as Chance is) rather than to GOD *(a)*. It is a Sign the Man is wilfully blind, that

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(a) Galen having taken Notice of the neat Diſtribution of the Nerves to the Muſcles, and other Parts of the Face, cries out, *Hæc enim fortunæ ſunt opera! Cæterùm tum omnibus* [partibus] *immitti, tantoſque eſſe ſingulos* [nervos] *magnitudine, quanta particulæ erat neceſſe; haud ſcio an hominum ſit ſobriorum ad Fortunam opificem id revocare. Alioqui quid tandem erit, quod cum Providentiâ et Arte efficitur? Omnino enim hoc ei contrarium eſſe debet, quod Caſu ac Fortuitò fit.* And afterwards, *Hæc quidem neque ejuſmodi Artis ſcil. ac Sapientiæ opera eſſe dicemus, ſi modò Fortunæ*

that he is under the Power of the Devil, under the Government of Prejudice, Luſt, and Paſſion, not right Reaſon, that will not diſcern what *every one can ſee, what every Man may behold afar off*, even the Exiſtence and Attributes of the CREATOR from his Works. For as *there is no Speech or Language where their Voice is not heard, their Line is gone out through all the Earth, and their Words to the End of the World:* So all, even the barbarous Nations, that never heard of GOD, have from theſe his Works inferred the Exiſtence of a Deity, and paid their Homages to ſome Deity, although they have been under great Miſtakes in their Notions and Concluſions about Him. But however, this ſhews how naturally and univerſally all Mankind agree, in deducing their Belief of a God from the Contemplation of his Works, or as even *Epicurus* himſelf, in *Tully* (*b*), ſaith, from *a Notion that Nature itſelf hath imprinted upon the Minds of Men. For*, ſaith he, *what Nation is there, or what kind of Men, that without any Teaching or Inſtructions, have not a kind of Anticipation, or preconceived Notion of a Deity?*

An Atheiſt therefore (if ever there was any ſuch) may juſtly be eſteemed a Monſter among rational Beings; a Thing hard to be met with in the whole Tribe of Mankind; an Oppoſer of all the

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Fortunæ tribuenda ſunt quæ ſunt contraria; fietque jam quod in proverbiis—Fluvii ſurſum fluent; ſi opera quæ nullum habent neque ornamentum neque rationem, neque modum Artis eſſe; contraria vero Fortunæ duxerimus, etc. Galen. ubi ſupra, lib. xi. cap. 7.

(*b*) *Primùm eſſe Deos, quod in omnium animis, etc.* And a little after, *Cùm enim non inſtituto aliquo, aut more, aut lege ſit opinio conſtituta, maneatque ad unum omnium firma conſenſio, intelligi neceſſe eſt, eſſe Deos, quoniam inſitas eorum, vel potiùs innatas cognitiones, habemus. De quo autem omnium Natura conſentit, id verum eſſe neceſſe eſt. Eſſe igitur Deos confitendum eſt.* Cicer. de Nat. Deor. lib. i. cap. 16, 17.

World *(c)*; a Rebel againſt human Nature and Reaſon, as well as againſt his God.

But above all, monſtrous is this, or would be, in ſuch as have heard of God, who have had the Benefit of the clear Goſpel Revelation. And ſtill more monſtrous this would be, in one Born and Baptized in the Chriſtian Church, that hath ſtudied Nature, and pried farther than others into God's Works. For ſuch an one (if it be poſſible for ſuch to be) to deny the Exiſtence, or any of the Attributes of God, would be a great Argument of the infinite Inconvenience of thoſe Sins of Intemperance, Luſt, and Riot, that have made the Man abandon his Reaſon, his Senſes, yea, I had almoſt ſaid his very human Nature *(d)*, to engage him thus to deny the Being of God.

So alſo it is much the ſame monſtrous Infidelity, at leaſt betrays the ſame Atheiſtical Mind, to deny God's Providence, Care, and Government of the World, or (which is a Spawn of the ſame *Epicurean Principles*) to deny *Final Cauſes (e)* in God's Works of Creation; or with the Profane, in *Pſal.* lxxiii. 11: to ſay, *How doth God know? And is there Knowledge in the moſt High?* For, as the witty and eloquent *Salvian* ſaith *(f)*, *They that affirm nothing is ſeen by*

(c) The Atheiſt in denying a God, doth, as *Plutarch* ſaith, endeavour—*Immobilia movere, et bellum inferre non tantùm longo tempori, ſed et multis hominibus, gentibus, et familiis, quas religioſus Deorum cultus, quaſi divino furore correptas, tenuit.* Plutar. de Iſide.

(d) See before, *Note (b).*

(e) Galen having ſubſtantially refuted the *Epicurean* Principles of *Aſclepiades*, by ſhewing his Ignorance in Anatomy and Philoſophy, and by demonſtrating all the *Cauſes*, to be evidently in the Works of *Nature*, viz. *Final*, *Efficient*, *Inſtrumental*, *Material*, and *Formal Cauſes*, concludes thus againſt his fortuitous Atoms, *Ex quibus intelligi poteſt: Conditorem noſtrum in formandis particulis unum hunc ſequi ſcopum, nempe ut quod melius eſt eligat.* Galen. de Uſu Part. lib. vi. cap. 13.

(f) De Gubern. Dei, lib. iv. p. 124. *meo Libro*; alſo lib. vii. cap. 14.

GOD, will, in all Probability, *take away the Subſtance, as well as Sight of God.——But what ſo great Madneſs,* ſaith he, *as that when a Man doth not deny GOD to be the Creator of all Things, he ſhould deny him to be the Governor of them? Or when he confeſſeth him to be the Maker, he ſhould ſay, GOD neglecteth what he hath ſo made?*

CHAP. IV.

That God's Works ought to excite us to Fear and Obedience to God.

SInce the Works of the Creation are all of them ſo many Demonſtrations of the infinite Wiſdom and Power of God, they may ſerve to us as ſo many Arguments exciting us to the conſtant *Fear of God*, and to a ſteady, hearty *Obedience* to all his Laws. And thus we may make theſe Works as ſerviceable to our ſpiritual Intereſt, as they all are to our Life, and temporal Intereſt. For if whenever we ſee them, we would conſider that theſe are the Works of our infinite *Lord* and *Maſter*, to whom we are to be accountable for all our Thoughts, Words, and Works, and that in theſe we may ſee his infinite Power and Wiſdom; this would check us in Sinning, and excite us to ſerve and pleaſe him who is above all Controul, and who hath our Life and whole Happineſs in his Power. After this Manner GOD himſelf argues with his own *fooliſh People, and without Underſtanding, who had Eyes, and ſaw not, and had Ears, and heard not,* Jer. v. 21, 22. *Fear ye not me? ſaith the Lord: will ye not tremble at my Preſence, which have placed the Sand for the Bound of the*

the Sea, by a perpetual Decree, that it cannot paſs it; and though the Waves thereof toſs themſelves, yet can they not prevail; though they roar, yet can they not paſs over it?

This was an Argument that the moſt ignorant, ſtupid Wretches could not but apprehend; that a Being that had ſo vaſt and unruly an Element, as the Sea, abſolutely at his Command, ought to be feared and obeyed, and that he ought to be conſidered as the Sovereign Lord of the World, on whom the World's Proſperity and Happineſs did wholly depend; *ver.* 24. *Neither ſay they in their Heart, Let us now fear the Lord our God, that giveth Rain, both the former and the latter in his Seaſon: He reſerveth unto us the appointed Weeks of the Harveſt.*

CHAP. V.

That God's Works ought to excite us to Thankfulneſs.

AS the Demonſtrations which GOD hath given of his infinite *Power* and *Wiſdom* ſhould excite us to Fear and Obedience; ſo I ſhall ſhew in this Chapter, that the Demonſtrations which he hath given of his infinite *Goodneſs* in his Works, may excite us to due Thankfulneſs and Praiſe. It appears throughout the foregoing Survey, what Kindneſs GOD hath ſhewn to his Creatures in providing every Thing conducing to their Life, Proſperity, and Happineſs (*a*); how they are all contrived and made in the

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(*a*) *Si pauca quis tibi donâſſet jugera, accepiſſe te diceres beneficium: immenſa terrarum latè patentium, ſpatia negas eſſe* the beſt Manner, placed in the fitteſt Places of the World for their Habitation and Comfort; accoutered in the beſt Manner, and accommodated with every, even all the minuteſt Things that may miniſter to their Health, Happineſs, Office, Occaſions, and Buſineſs in the World.

Upon which Account, Thankfulneſs and Praiſe is ſo reaſonable, ſo juſt a Debt to the *Creator*, that the *Pſalmiſt* calleth upon all the Creatures to praiſe God, in *Pſalm* cxlviii. *Praiſe him all his Angels, Praiſe him all his Hoſts; Sun, Moon, Stars of Light, Heavens of Heavens, and Waters above the Heavens.* The Reaſon given for which is, *ver.* 5, 6. *For he commanded, and they were created; he hath alſo eſtabliſhed them for ever and ever; he hath made a Decree which they ſhall not paſs.* And not theſe Celeſtials alone, but the Creatures of the Earth and Waters too, even the Meteors, *Fire and Hail, Snow and Vapours, ſtormy Winds fulfilling his Word.* Yea, the very *Mountains and Hills, Trees, Beaſts, and all Cattle, creeping Things, and flying Fowl.* But in a particular Manner, all the Ranks and Orders, all the Ages and Sexes of Mankind are charged with this Duty; *Let them praiſe the Name of the Lord, for his Name alone is excellent; his Glory is above the Earth and Heavens,* ver. 13.

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eſſe beneficium? Si pecuniam tibi aliquis donaverit, — beneficium vocabis: tot metalla defodit, tot flumina emiſit in æra, ſuper quæ decurrunt ſola aurum vehentia: argenti, æris, ferri immane pondus omnibus locis obrutum, cujus inveſtigandi tibi facultatem dedit, — negas te accepiſſe beneficium? Si domus tibi donetur, in quâ marmoris aliquid reſplendeat, &c. Num mediocre munus vocabis? Ingens tibi domicilium, ſine ullo incendii, aut ruinæ metu ſtruxit, in quo vides non tenues cruſtas — ſed integras lapidis pretioſiſſimi moles, etc. negas te ullum munus accepiſſe? Et cùm iſta quæ habes magno æſtimes, quod eſt ingrati hominis, nulli debere te judicas? Unde tibi iſtum quem trahis ſpiritum? Unde iſtam, per quam ductus vitæ tuæ diſponis atque ordinas, lucem? etc. Senec. de Benef. lib. iv. cap. 6.

And great Reaſon there is we ſhould be excited to true and unfeigned Thankfulneſs and Praiſe *(b)* to this our great Benefactor, if we reflect upon what hath been ſhewn in the preceding Survey, that the *Creator* hath done for Man alone, without any Regard to the reſt of the Creatures, which ſome have held were made for the Sake of Man. Let us but reflect upon the Excellence and Immortality of our Soul; the incomparable Contrivance, and curious Structure of out Body; and the Care and Caution taken for the Security and Happineſs of our State, and we ſhall find, that among the whole Race of Beings, Man hath eſpecial Reaſon to magnify the Creator's Goodneſs, and with ſuitable ardent Affections to be thankful unto him.

(b) *Tempeſtivum tibi jam fuerit, qui in hiſce libris verſaris conſiderare, in utram Familiam recipi malis,* Platonicamne *ac* Hippocraticam, *et aliorum viorum, qui Naturæ opera mirantur; an eorum qui ea inſectantur, quod non per Pedes natura conſtituit effluere Excrementa.* Of which having told a Story of an Acquaintance of his, that blamed Nature on this Account, he then goes on, *At verò ſi de hujuſmodi pecudibus plura verba fecero, melioris mentis homines meritò mihi forte ſuccenſeant, dicantque me polluere ſacrum ſermonem, quem ego* CONDITORIS *noſtri verum Hymnum compono, exiſtimoque in eo veram eſſe pietatem,— ut ſi noverim ipſe primus, deinde et aliis expoſuerim, quænam ſit ipſius Sapientia, quæ Virtus, quæ Bonitas. Quod enim cultu conveniente exornaverit omnia; nullique bona inviderit, id perfectiſſimæ Bonitatis ſpecimen eſſe ſtatuo; et hac quidem ratione ejus Bonitas Hymnis nobis eſt celebranda. Hoc autem omne inveniſſe quo pacto omnia potiſſimùm adornarentur, ſummæ Sapientiæ eſt: effeciſſe autem omnia, quæ voluit, Virtutis eſt invictæ.* Galen. de Uſu Part. lib. iii. cap. 10.

CHAP. VI.

That we ought to pay God all due Homage, and Worſhip, particularly that of the Lord's Day.

FOR a Concluſion of theſe Lectures, the laſt Thing I ſhall infer, from the foregoing Demonſtration of the Being and Attributes of GOD, ſhall be, that we ought to pay GOD all that *Homage* and *Worſhip* which his Right of Creation and Dominion entitle him unto, and his great Mercies call for from us. And foraſmuch as the *Creator* appointed, from the very Creation, one Day in ſeven to his Service, it will not therefore be improper to ſay ſomething upon that Subject: And if I inſiſt ſomewhat particularly and largely thereon, the Congruity thereof to the Deſign of theſe Lectures, and the foregoing Demonſtration, together with the too great Inadvertency about, and Neglect of, this antient, univerſal, and moſt reaſonable and neceſſary Duty, will, I hope, plead my Excuſe. But that I may ſay no more than is neceſſary on this Point, I ſhall confine myſelf to two Things; the *Time* God hath taken, and the *Buſineſs* then to be performed.

I. The *Time* is one Day in ſeven, and one of the antienteſt Appointments it is, which GOD gave to the World. For as ſoon as GOD had finiſhed his ſix Day's Works of Creation, it is ſaid, *Gen.* ii. 2, 3. *He reſted on the ſeventh Day from all his Work which he had made. And GOD bleſſed the ſeventh Day, and ſanctified it, becauſe that in it he had reſted from*

from all his Work. This Sanctification (*a*), and bleſſing the Seventh Day, was ſetting it apart, as a Day of Diſtinction from the reſt of the Week-Days, and appropriating it to Holy Uſes and Purpoſes, namely, the Commemoration of that Great Work of the Creation, and paying Homage and Worſhip to that Infinite Being, who was the Effector of it.

This Day, thus conſecrated from the Beginning, for the Celebration of the τȣ̃ κόσμȣ γενέσιον, the *World's Birth-Day*, as *Philo* calls it, was probably in ſome Meaſure forgotten in the following wicked Ages, which God complains of, *Gen.* vi. 5. and ſo after the Flood likewiſe. But after the Return out of *Egypt*, when GOD ſettled the *Jewiſh* Polity, he was pleaſed to renew this Day, and to eſtabliſh it for a perpetual ſtanding Law. And accordingly it was obſerved down to our Bleſſed SAVIOUR's Time, countenanced, and ſtrictly obſerved, by our Great LORD and Maſter himſelf, and his Apoſtles and Diſciples, in and after his Time; and although for good Reaſons the Day was changed by them, yet a ſeventh Day hath been conſtantly obſerved in all Ages of Chriſtianity, down to our preſent Time.

Thus we have a Day appointed by GOD himſelf, and obſerved throughout all Ages, except ſome few perhaps, which deſerve not to be brought into Example.

And a wiſe Deſignation of Time this is, well becoming the Divine Care and Precaution; ſerving for the recruiting our Bodies, and diſpatching our Affairs, and at the ſame Time to keep up a Spiri-

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(*a*) קדש *Uſibus divinis accommodavit, à communi et profano uſu ſegregavit, in uſum ſacrum ad cultum Dei deſtinavit.* Kirch. Concord. p. 1336. *Deſtinari ad aliquid, Sacrari, etc.* Buxtorf. in Verbo.

tual Temper of Mind. For by allowing ſix Days to Labour, the Poor hath Time to earn his Bread, the Man of Buſineſs Time to diſpatch his Affairs, and every Man Time for the Work of his reſpective Calling. But had there been more, or all our Time allotted to Labour and Buſineſs, and none to reſt and recruit, our Bodies and Spirits would have been too much fatigued and waſted, and our Minds have been too long engaged about worldly Matters, ſo as to have forgotten Divine Things. But the infinitely wiſe Ruler of the World, having taken the ſeventh Part of our Time to his own Service, hath prevented theſe Inconveniences; hath given a Relaxation to ourſelves; and Eaſe and Refreſhment to our wearied Beaſts, to poor fatigued Slaves, and ſuch as are under the Bondages of avaritious, cruel Maſters. And this is one Reaſon *Moſes* gives of the Reſervation and Reſt on the Seventh Day, *Deut.* v. 13, 14, 15. *Six Days ſhalt thou labour, and do all thy Work; but the Seventh is the Sabbath of the LORD thy GOD; in it thou ſhalt not do any Work, thou,* nor thy Children, Servants, Cattle, or Stranger, *that thy Man-Servant and Maid-Servant may reſt as well as thou. And remember, that thou waſt a Servant,* &c. *therefore the LORD thy GOD commanded thee to keep the Sabbath-Day.* That carnal, greedy People, ſo bent upon Gain, without ſuch a Precept, would have ſcarce favoured their own Bodies, much leſs have had Mercy upon their poor Bondſmen and Beaſts; but by this wiſe Proviſion, this great Burden was taken off. But on the other hand, as a longer Liberty would too much have robbed the Maſter's Time, and bred Idleneſs, ſo by this wiſe Proviſion, of only one Day of Reſt, to ſix of Labour, that Inconvenience was alſo prevented.

Thus the wiſe Governor of the World hath taken Care for the Diſpatch of Buſineſs. But then as too long Engagement about worldly Matters, would take off Mens Minds from God and Divine Matters, ſo by this Reſervation of every Seventh Day, that great Inconvenience is prevented alſo; all being then bound to Worſhip their Great Lord and Maſter, to pay their Homages and Acknowledgments to their infinitely kind Benefactor; and, in a Word, to exerciſe themſelves in divine, religious Buſineſs, and ſo keep up that ſpiritual Temper of Mind, that a perpetual, or too long Application to the World would deſtroy.

This, as it was a good Reaſon for the Order of a Sabbath to the *Jews*; ſo is as good a Reaſon for our Saviour's Continuance of the like Time in the Chriſtian Church.

And a Law this is, becoming the infinitely wiſe Creator and Conſervator of the World; a Law, not only of great Uſe to the Perpetuating the Remembrance of thoſe greateſt of God's Mercies then commemorated, but alſo exactly adapted to the Life, Occaſions, and State of Man; of Man living in this, and a-kin to another World: A Law well calculated to the Diſpatch of our Affairs, without hurting our Bodies or Minds. And ſince the Law is ſo wiſe and good, we have great Reaſon then to practiſe carefully the Duties incumbent upon us: which will fall under the Conſideration of the

II. Thing I propoſed, the *Buſineſs* of the Day, which God hath reſerved to himſelf. And there are two Things enjoined in the Commandment, a *Ceſſation* from Labour and worldly Buſineſs; and that we *remember to keep the* Day Holy.

1. There muſt be a Ceſſation from worldly Buſineſs, or a Reſt from Labour, as the Word *Sabbath* (b) ſignifies. *Six Days thou ſhalt do all thy*

(b) שבת *Ceſſatio, Requies.*

Work, but the Seventh is the Sabbath of the Lord thy GOD, (not thy Day, but his,) *in which neither thou, nor any belonging to thee, ſhall do any Work.* In which Injunction it is obſervable, how expreſs and particular this Commandment is, more than others, in ordering all Sorts of Perſons to ceaſe from Work.

2. We muſt *remember to keep the Day Holy.* Which *Remembrance* is another Thing alſo in this, more than in the other Commandments, and implies,

1ſt, That there is great Danger of our forgetting, neglecting, or being hindered from keeping the Day Holy, either by the Infirmity and Carnality of our own Nature, or from the Avocations of the World.

2dly, That the keeping it Holy, is a Duty of more than ordinary Conſequence and Neceſſity. And of greateſt Conſequence this is,

Firſt, to perpetuate the Remembrance of thoſe grand Works of GOD commemorated on that Day; in the firſt Ages of the World, the Creation; in the Middle Ages, the Creation and Delivery from *Egypt*; and under Chriſtianity, the Creation and Redemption by Chriſt. Which Mercies, without ſuch frequent Occaſions, would be ready to be forgotten or diſregarded, in ſo long a Tract of Time, as the World hath already ſtood, and may, by God's Mercy, ſtill ſtand.

Secondly, To keep up a ſpiritual Temper of Mind, by thoſe frequent weekly Exerciſes of Religion, as hath been already mentioned.

Thirdly, To procure GOD's Bleſſing upon the Labours and Buſineſs of our ſix Days, which we can never expect ſhould be proſperous, if we are negligent of GOD's Time. For how can we expect GOD's Bleſſing upon a Week ſo ill begun, with a Neglect, or Abuſe of GOD's firſt Day? And therefore if we become unproſperous in the World; if

Loſſes, Troubles, or Dangers befall us, let us reflect how we have ſpent the *Lord*'s Day; whether we have not wholly neglected it, or abuſed it in Riot, or made it a Day for taking Journeys, for more private Buſineſs, and leſs ſcandalous Labour, as the Cuſtom of too many is.

Thus having ſhewn what Reaſon there is to *remember* to keep Holy the Day dedicated to GOD, I ſhall conſider how we are to keep it Holy, and ſo conclude. Now the Way to keep it Holy, is not by bare reſting from Work; for that, as a Father ſaith, is *Sabbatum Boum & Aſinorum*, a *Sabbath of Beaſts*: But holy Acts are the proper Buſineſs for a Holy Day, celebrated by rational Beings. Among all which, the grand, principal, and moſt univerſally practiſed, is the *Publick Worſhip of GOD*, the aſſembling at the *Publick Place* of his *Worſhip*, to pay (with our Fellow-Creatures) our Homages, Thanks, and Praiſes to the infinite *Creator* and *Redeemer* of the World. This, as it is the moſt reaſonable Service, and proper Buſineſs for this Day, ſo is what hath been the Practice of all Ages. It was as early as *Cain* and *Abel*'s Days, *Gen.* iv. 3, what was practiſed by religious Perſons in the following Ages, till the giving of the Law; and at the giving of That, God was pleaſed to order Places, and his particular Worſhip, as well as the Seventh Day. The Tabernacle and Temple were appointed by God's expreſs Command; beſides which, there were Synagogues all over the Nation; ſo that in our Saviour's Time every great Town, or Village, had one, or more in it, and *Jeruſalem* 460, or more (c).

The Worſhip of theſe Places, our Bleſſed SAVIOUR was a conſtant and diligent Frequenter of. It is ſaid, *He went about all the Cities and Villages, Teaching in their Synagogues, and Preaching, and*

(c) See *Lightfoot*'s Works, vol. ii. p. 35, *and* 646.

Healing, &c. *Mat.* ix. 35. And St. *Luke* reporteth it as his conſtant Cuſtom and Practice, *Luke* iv. 16. *And as his Cuſtom was, he went into the Synagogue on the Sabbath-Day.*

Having thus mentioned the Practice of CHRIST, it is not neceſſary I ſhould ſay much of the Practice of his *Apoſtles*, and the following purer Ages of Chriſtianity, who, in ſhort, as their Duty was, diligently followed their great Maſter's Example. *They did not think it enough to read and pray, and praiſe God at Home, but made Conſcience of appearing in the Publick Aſſemblies, from which nothing but Sickneſs and abſolute Neceſſity did detain them; and if Sick, or in Priſon, or under Baniſhment, nothing troubled them more, than that they could not come to Church and join their Devotions to the common Services. If Perſecution at any Time forced them to keep a little Cloſe; yet no ſooner was there the leaſt Mitigation, but they preſently returned to their open Duty, and Publickly met all together. No trivial Pretences, no light Excuſes, were then admitted for any one's Abſence from the Congregation, but, according to the Merit of the Cauſe, ſevere Cenſures were paſſed upon them*, &c. to expreſs it in the Words of one of our beſt Antiquaries (*d*).

The *Publick Worſhip* of GOD then, is not a Matter of Indifference, which Men have in their own Power to do, or omit, as they pleaſe; neither is it enough to read, pray, or praiſe God at Home, (unleſs ſome inevitable Neceſſity hindereth;) becauſe the appearing in GOD's Houſe, on *his* Day, is an Act of *Homage* and *Fealty*, due to the CREATOR, a *Right of Sovereignty* we pay him. And the withholding thoſe Rights and Dues from GOD, is a kind of rejecting GOD, a diſowning his Sovereignty, and a withdrawing our Obedience and Service.

(*d*) Dr. *Cave's Primitive Chriſtianity*, part 1. chap. 7.

And this was the very Reaſon why the Profanation of the Sabbath was puniſhed with Death among the *Jews*, the Sabbath being a Sign or Badge of the GOD they owned and worſhipped *(e)*. Thus *Exod.* xxxi. 13. *My Sabbaths ye ſhall keep; for it is a SIGN between me and you, throughout your Generations; that ye may know that I am the LORD, that doth ſanctify you*; or, as the Original may be rendered, *A Sign to acknowledge, that I* Jehovah *am your Sanctifier*, or *your God*: For as our learned *Mede* obſerves, *To be the Sanctifier of a People, and to be their God, is all one.* So likewiſe very expreſly in *Ezek.* xx. 20.

(e) At this Day it is cuſtomary for Servants to wear the Livery of their Maſters, and others to bear Badges of their Order, Profeſſion, Servility, *etc.* So in former Ages, and divers Countries, it was uſual to bear Badges, Marks, and Signs on divers Occaſions. In *Ezek.* ix. 4. *A Mark was to be ſet on the Forehead of thoſe that lamented the Abominations of the City.* The like was to be done upon them in *Rev.* vii. 3. and ix. 4. So the Worſhippers of the Beaſt, *Rev.* xiii. 16. were to receive a Χάραγμα, *A Mark in their right Hand, on their Foreheads.* Thoſe Χαράγματα, Σφραγίδες, *Badges*, &c. were very common. Soldiers and Slaves bear them in their Arms or Foreheads; ſuch as were matriculated in the *Heteriæ*, or Companies, bear the Badge or Mark of their Company; and whoever liſted himſelf into the Society of any of the ſeveral *Gods*, received a Χάραγμα, or a Mark in his Body, (commonly made with red-hot Needles, or ſome burning in the Fleſh,) of the God he had liſted himſelf under. And after Chriſtianity was planted, the Chriſtians had alſo their *Sign of the Croſs.* And not only Marks in their Fleſh, Badges on their Cloaths, *etc.* were uſual; but alſo the Dedication of Days to their imaginary Deities. Not to ſpeak of their Feſtivals, *etc.* the Days of the Week were all dedicated to ſome of their Deities. Among the *Romans*, Sunday and Monday, to the *Sun* and *Moon*; Tueſday to *Mars*; Wedneſday to *Mercury*, &c. So our *Saxon* Anceſtors did the ſame; Sunday and Monday, (as the *Romans* did,) to the *Sun* and *Moon*; Tueſday to *Tuyſco*; Wedneſday to *Woden*; Thurſday to *Thor*; Friday to *Friga*; and Saturday to *Seater*: An Account of which Deities, with the Figures under which they were worſhipped, may be met with in our learned *Verſtegan*, chap. iii. p. 68.

Hallow my Sabbaths, and they ſhall be a Sign between me and you, that ye may know that I am the LORD your GOD; or rather as before, *to acknowledge that I JEHOVAH am your GOD*.

The Sabbath being thus a Sign, a Mark, or Badge, to acknowledge God to be their God, it follows, that a Neglect or Contempt of that Day, redounded to GOD; to ſlight that, was ſlighting God; to profane that, was to affront God; for the Puniſhment of which, What more equitable Penalty than Death? And although under Chriſtianity, the Puniſhment is not made Capital, yet have we no leſs Reaſon for the ſtrict Obſervance of this Holy Day, than the *Jews*, but rather greater Reaſons. For the GOD we Worſhip, is the ſame: If after ſix Days Labour, he was, by the Seventh, owned to be GOD, the *Creator*; no leſs is he by our Chriſtian Lord's-Day: If by the Celebration of the Sabbath, the Remembrance of their Deliverance from the *Egyptian* Bondage was kept up, and GOD acknowledged to be the Effector thereof; we Chriſtians have a greater Deliverance, we own our Deliverance from Sin and Satan, wrought by a greater Redeemer than *Moſes*; even the Bleſſed JESUS, whoſe Reſurrection, and the Completion of our Redemption thereby, was performed on the Chriſtian Lord's-Day.

And now, to ſum up, and conclude theſe Inferences, and ſo put an End to this Part of my Survey: Since it appears, that the Works of the LORD are ſo great, ſo wiſely contrived, ſo accurately made, as to deſerve to be enquired into; ſince they are alſo ſo manifeſt Demonſtrations of the Creator's Being and Attributes, that all the World is ſenſible thereof, to the great Reproach of Atheiſm: What remaineth? But that we fear and obey ſo great and tremendous a Being; that we be truly thankful for, and magnify and praiſe his infinite Mercy, manifeſted to us in his Works. And foraſmuch as he hath appointed a Day on Purpoſe from the Beginning, for theſe Services, that we may weekly meet together, commemorate and celebrate the great Work of Creation; that we may pay our Acts of Devotion, Worſhip, Homage, and Fealty to him; and ſince this is a wiſe and excellent Diſtribution of our Time, What ſhould we do, but conſcientiouſly and faithfully pay GOD theſe his Rights and Dues? and as carefully and diligently manage GOD's Time, and diſcharge his Buſineſs then, as we do our own upon our ſix Days; particularly that with the pious *Pſalmiſt*, *We love the Habitation of God's Houſe, and the Place where his Honour dwelleth*; and therefore take up his good Reſolution in *Pſal.* v. 7. with which I ſhall conclude; *But as for me, I will come into thine Houſe in the Multitude of thy Mercy, and in thy Fear will I worſhip towards thy Holy Temple.*

Now to the ſame Infinite GOD, the Omnipotent Creator and Preſerver of the World, the moſt gracious Redeemer, Sanctifier, and Inſpirer of Mankind, be all Honour, Praiſe, and Thanks, now and ever. *Amen.*

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